

# Communicating the Modern Body: Fritz Kahn's Popular Images of Human Physiology as an Industrialized World

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*Abstract:* The visualization of the human body has always been a highly popular affair, and popular science writing has been particularly perceptive as to how new media has revolutionized science. This article analyzes the intertwining of science, culture, and technology by investigating the lavishly illustrated publications of Fritz Kahn, arguably one of the most successful popular science writers internationally between 1920 and 1960. His illustrations developed a specific style of visualization that positioned the human body firmly in an industrial modernity of machine analogues, which he eventually copyrighted as a product line. This visual crossover between industrialization and science demonstrates surprisingly accurately how human nature becomes historically contingent and culturally encoded.

*Keywords:* Visual communication; Print culture; Philosophy; History; Cultural studies of science and medicine

*Résumé :* La représentation du corps humain a toujours été une activité très populaire, et les œuvres de vulgarisation scientifique ont eu une perception particulièrement sensible aux manières dont les nouveaux médias ont révolutionné la science. Cet article analyse les interactions entre science, culture et technologie en examinant les publications richement illustrées de Fritz Kahn, un des auteurs de vulgarisation scientifique les plus populaires à l'échelle internationale entre 1920 et 1960. Par ses illustrations, il a développé un style spécifique de représentation situant le corps humain fermement dans le contexte d'une modernité industrielle privilégiant le rapport du corps à la machine, une approche qu'il a fini par faire breveter. Ce rapprochement visuel entre l'industrialisation et la science démontre avec une précision surprenante la variabilité historique et l'encodage culturel de la nature humaine.

*Mots clés :* communication visuelle; culture de l'imprimé; philosophie; histoire; études culturelles en sciences et en médecine

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### Man, the industrial palace

In a special effort to increase the visibility of *Das Leben des Menschen (The Life of Man)*, a “popular anatomy and physiology of the human body” by Fritz Kahn, its publishers decided to print an oversize poster version of one of his suggestive illustrations as an aside. At 1 by 0.5 metres, it showed the interior workings of the upper part of a human body (see Figure 1)<sup>1</sup>. The head and trunk of the figure were open to lay bare the organs and their operations, but instead of bones, nerves, or blood vessels, the image showed an intricate arrangement of machine parts. In one place, large pistons pumped blue and red particles into a ramified tubing system, while a huge ventilation apparatus right next to it circulated air in and out of the body. Elsewhere, chains of conveyer belts transported chunks and pieces along a series of chopping and crushing stations until basic units were finally transferred to a different compartment of chemical synthesis. Further machinery was needed to maintain the production complexes, to provide drainage, and to maintain pressure. In addition, information systems of several forms linked all compartments with centralized offices for calculation, communication, and control at the top. While the depicted figure is unambiguously demarcated as human by its silhouette and, in particular, its profile of a human face looking to the right, the installations in the body’s interior appear to be as convoluted as an industrial complex that has to accommodate ever-more production lines in its limited quarters.

Only upon closer inspection does it become clear how the illustration assembles specific machinery to represent a particular organ and its function within its natural place. Following this strategy, the ventilation system, for example, stands in for the lungs and the mechanical break-up of substances along the chain of conveyer belts represents the digestive tract, while the chemical plant is an analogue of the liver. Indeed, the image obeys the details of vertebrate anatomy to a surprising degree: the motor has two pistons as the heart chambers and is located to the body’s left, the ventilation apparatus is bifurcated as the two parts of the lung, and a spherical tank in close proximity to the chemical factory collects special fermenting fluids and releases them into the digestive tract slightly underneath the stomach’s exit, just where the bile enters from the gallbladder into the jejunum. In some instances this topographical realism permeates the shape of the machine analogue of the depicted organ, as in the case of the stomach and bowels, where the retained gestalt qualities stand in for a somewhat uncertain industrial process. At other times, the image employs some of the conventional coding systems that had become standard practice in coloured anatomical illustrations by the 1920s, as, for example, in the use of red and blue for oxygenated arterial and de-oxygenated venous blood and their respective vessels.

Perhaps most striking is how literally the machine analogues stand in for the body’s organs. Conventionally, one may *speak* of the image explaining a particular body function or the operations of an organ by means of a machine analogue, but here, the images show the human body to be made up of these machines. If this were a conventional anatomical chart, the printed labels would be redundant. Here, however, they denote each industrial compartment as a particular organ; they fuse the biological with the technological object. As I will argue later, it is

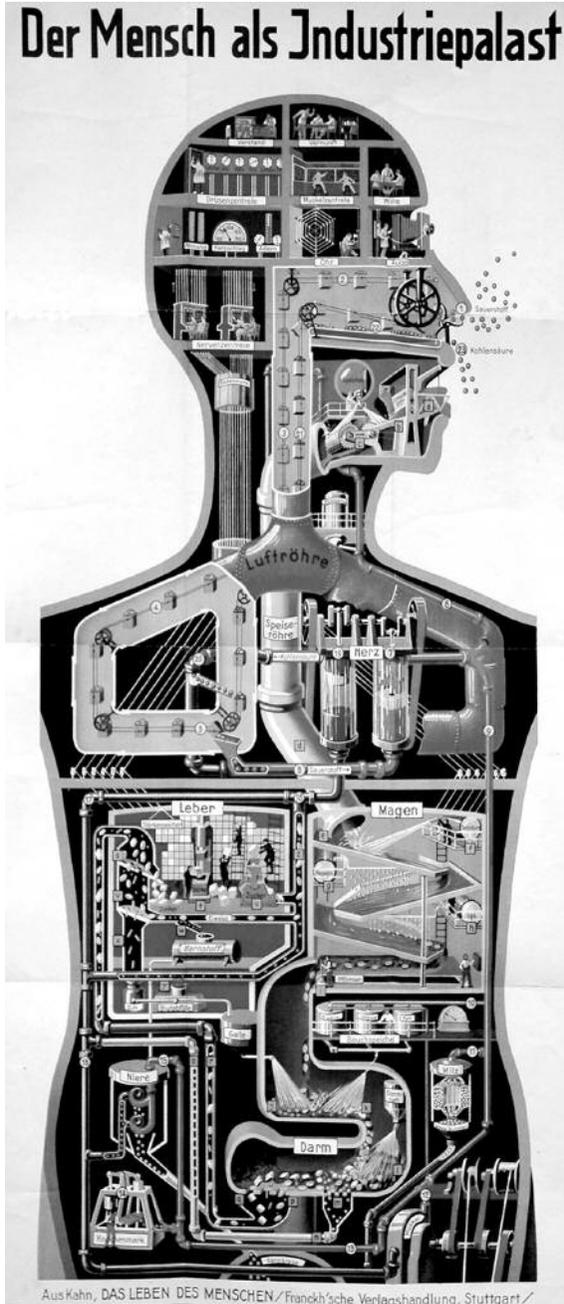


Figure 1: Fritz Kahn: *Der Mensch als Industriepalast* (Man as Industrial Palace), supplemental poster (1.0 x 0.5 m) to Kahn's monumental popular anatomy and physiology (Kahn, 1922-1931, Vo. 3)

precisely the fusion of the human body with a machine ensemble that turns this mode of visualization into an epistemologically significant constellation. It may well be that the strategy of comparing bodily organs with machines and illustrating them as such was chosen solely for educational reasons or was regarded as an advantageous form for communicating a modern body image, but this does not limit, as I argue in the concluding part of this paper, the epistemological significance of this mode of visualization.

*Man as Industrial Palace* is, like the other images to be analyzed here, first of all an historical artifact testifying to the cultural context in which it emerged. In this respect it formed part of the broader contemporary debates about rationalization and technological progress in conjunction with the ongoing industrial modernization of Weimar Germany. The poster appears to be an almost prototypical example of the *Neue Sachlichkeit*, the period's idealized representation of its era as rational and clean, technological and sanitized modernity. In its stylish appearance, the image also shares important features with the emergent culture of industrial design, advertising, and economic commodification, as the following sections aim to show, but again, the significance of *Man as Industrial Palace* goes beyond being a typical example of a particular culture. Kahn's images reveal how scientific knowledge was shaped by printing techniques and circulation modes, educational aims and subscription rates, economic considerations and copyright restrictions, deeply engrained gender stereotypes within a universalistic agenda, the availability of new media, and other technological advances.

The datedness of Kahn's visuals, finally, which facilitates their analysis as cultural artifacts, should not be mistaken as indicating an obsolescence of the visualized epistemology. Quite to the contrary, there is evidence that things have not much changed conceptually—and that makes Kahn's images troublesome, if not haunting. Kahn's imagery unfolds as a visualization of the (technological) nature of biological knowledge; it is so remarkable precisely in its alleged shortcomings or inaccuracies. The identification of body and machine visualizes how the life sciences come to know the body.

### **An industrious production line**

The *Man as Industrial Palace* image forms part of a cultural setting that appears to be modern, even if now historically remote. The production of this poster, as of similar popularization efforts in general, required an entire array of historical circumstances, among them the development of a complete set of printing and publishing technologies; the emergence of a middle class aspiring to participate in bourgeois cultures of knowledge; the differentiation of the book market, with entrepreneurs seeking new formats for emerging markets, et cetera (Johns, 1998; Weedon, 2003; Wittmann, 1991; Zboray & Zboray, 2005). In addition, science and technology had to be at least advanced to the level depicted—for example, to the stage of electric and synthetic chemical industry, the major indicators of the so-called second Industrial Revolution, and advanced communication technology such as telephone, radio, centralized electric control, and steering devices. These technical details anchor the image firmly in its contemporary culture, the turbulent interwar period that saw a massive wave of modernization in Western societies in general and in Weimar Germany in particular.

Though not new, science popularization participated actively in this modernization, as the advancement of scientific knowledge was regarded as one of the best ways to secure the advancement of society at large. The branching out of the sciences in ever-more applied directions met with efforts to adapt spheres of ordinary life to scientific amelioration (Broman, 2002; Daum, 1998; Rabinbach, 1992). This was particularly true for the health and medicine sector, where broad educational campaigns were thought to be essential in countering the alleged degenerative effects of technological progress and social welfare (Broks, 1996; Cooter & Pumfrey, 1994; Gregory & Miller, 1998; Hilgartner, 1990; Shinn & Whitley, 1985). Many of these initiatives centred on exhibitions and the development of new visualization strategies. In Germany, the enormous success of the First International Hygiene Exhibition in Dresden in 1911, in terms of both critical praise and public attention, set the stage for the foundation of a permanent museum of national scope, resulting in the construction of revolutionary visualizations, from Dresden's famous transparent glass man to Werner Spalteholz' translucent organ preparations and the strategic planning of graphic displays (Brecht & Nikolov, 2000; Körner & Stercken, 2002; Roth, 1990; Schmidt, 1995). Similar initiatives took shape on more local levels. Berlin's city physician Ernst Joël, for example, created the "Healthy Nerves" exhibition for the newly opened "health centre" in Berlin-Kreuzberg, as famously described by Walter Benjamin (Benjamin, 1972). Internationally one could refer to, for example, Francis Galton's test and measurement rooms at the International Health Exhibition in 1884 in London or the many initiatives for preaching the eugenics gospel that were to follow (Brookes, 2004; Gillham, 2001; Weindling, 1989). Communication about the body, and especially the dissemination of a particular understanding of health risks—in short, the implementation of a regime of new bodily and behavioural responsibilities—had become an important part of public health, and thus of the modern governmentality (Foucault, 2004).

Three other branches of visualization strategy shaping the contemporary repertoire of visual formats should, at least briefly, be mentioned here; these lay outside of the public health sector, but relied hardly less on communicating the human, social, and political body. The first is the development of a graphic language for visualizing collectives such as the population or statistical bodies of data; the second is the professionalization of industrial design and exhibition-making at the Bauhaus; and the third, finally, is the hybridization of bodies and machines in the new genre of photomontage by Dada artists like Raoul Hausmann and Hannah Höch.

Otto Neurath made the visualization of the collective body the focus of his museum for economics and statistics in Vienna, which he had set up to educate the public about the statistical basis of modern life and its underpinnings, from birth rates to the distribution of qualifications and monthly earnings (Neurath, 1984; Nikolov, 2005). Specifically for visualizing complex statistical data, Neurath hired the avant-garde artist Gerd Arntz from Cologne, who developed the basic principles of a new visual code in which the symbols employed represented statistical phenomena through shape and size. This iconographic language of statistics has been standardized internationally and developed further under the name ISOTYPE (Lupton, 1986).

The Bauhaus obviously formed part of the visualization efforts during the period in many ways. The best-known examples are probably its activities in typography and industrial design while located at Dessau (Bartram, 2004). Less well known, but more directly linked to the context here, is the specialization in exhibition design, where Walter Gropius and Herbert Bayer, among others, created the concept of an integrated display for fostering the apprehension of the exhibited material by strict adherence to principles derived from gestalt psychology and from the Bauhaus' own typographic revolution (Brüning, 1999). Gropius and Bayer were also among those who responded directly to Kahn's works; for example, Gropius used several of Kahn's images for his lectures in "Design Topics" (Gropius, 1955). Bayer, a Bauhaus student (later Bauhaus teacher and head of the printing section), used Kahn's visualization style in, for example, the "*Wunder des Lebens*" show in Berlin in 1935 (Kasher, 1992), shortly before he emigrated to the U.S.

In contrast with the high degree of visibility of the Bauhaus, the direct impact of the radically new visual repertoire of the Berlin Dadaists is difficult to gauge. Their noisy political activism in the early 1920s had resulted in a somewhat vacillating prominence, but their artworks and visual objects were probably less well known than today. A chance to see at least some of Hausmann's prosthetic collages, with their machine parts grafted harshly onto human bodies, came with the first official exhibition on photomontage in Berlin in 1931; in contrast, the first Hannah Höch exhibition, scheduled for 1932 at the Bauhaus Dessau, fell victim to the rise of the Nazis when this forced the Bauhaus to move for a second time before finally being expelled the following year (Borck, 2005; Lavin, 1993). Compared with the radical visualization practices of the avant-garde, the modernism of images like *Man as Industrial Palace* resided less in the visual strategies and more in the technology depicted. A rather conventional realism of a highly unconventional technologized anatomy provokes bewildering fascination.

Like many other images, *Man as Industrial Palace* was designed to attract large audiences and produced explicitly for purposes of science popularization. Already by the end of the nineteenth century, scientists and educators were paying the public special attention in their efforts to increase the general understanding of the natural sciences. The availability of new printing technologies for the efficient and cheap reproduction of images and photographs made print media the ideal means for such purposes (Beegan, 1995; Schröder, 1990; Wolf, 1990). By the 1920s, illustrated weekly magazines had become a hugely popular format, as had small and affordable illustrated books. The case of the publishing house that printed the poster is particularly revealing in this respect.<sup>2</sup> The "Franckh'sche Verlagshandlung" had been established by the brothers Johann Friedrich and Friedrich Gottlob Franckh in the second quarter of the nineteenth century, specializing in the production of cheap pocket editions in the emerging sector of "classical" Bildung. At the end of the century, after the death of the brothers had shattered the business, a young duo of entrepreneurs bought the publishing house with an innovative business plan. Specifically with the aim of binding a science-interested audience to their publishing plans, the two founded an amateur society for naturalists, the *Gesellschaft der Naturfreunde* (which is still in existence),

with the members receiving *Kosmos*, a regular magazine, and subscribing to a serial publication of small cheap booklets, the *Kosmos Bücherei*.

Apparently, their business plan proved a huge success; within 10 years, the society grew to more than 100,000 members, and prominent science writers had successfully been recruited to contribute to the book series, which started with Wilhelm Bölsche writing on human evolution and Max Wilhelm Meyer on the likelihood of the end of the world (Bölsche, 1904; Meyer, 1904). World War I certainly brought an end to the fin-de-siècle setting in which this book program was nested, but the publishing house survived. Eager to follow the latest trends in science and technology after World War I, the publishers identified the new medium of radio as a topic for a print magazine, also expanding in the production of cheap radio sets for amateurs (soon to be complemented by mini-laboratories for aspiring young chemistry experimenters). At the same time, the *Kosmos* segment resumed the publication of the magazine and booklet series. This format was now well established, with annual production of four small volumes of roughly 80 pages each. Special discount rates for orders of 10 or more copies indicate that entire groups—maybe school classes, scout groups, or reading circles—must have joined in learning about science in this way. In fact, the format was so popular and successful that it was copied by other publishers and societies, most notably the left-wing *Urania*, the science-popularization initiative aimed at educating workers about radical science such as evolutionary theory, social epistemology, social physics, and future planning (Hopwood, 1996). The scientific materialism of the Marxist wing of the science popularizers obviously included the social and applied sciences and “progressive” humanities.

By their names alone, *Kosmos* and *Urania* already speak volumes about science popularization in Germany, which adapted classical standards of *Bildung* in Latin and Greek to the needs of a modern, techno-scientific period. While the young publishers opted for an explicit reference to Alexander von Humboldt’s famous (and popular) lectures in Berlin from the beginning of the nineteenth century, the Marxist education initiative from Jena decided with “*Urania*” to reinvent the famous bourgeois initiative in science popularization from Berlin as a socialist undertaking. During the 1920s, however, the popularization of science and technology had become mature and no longer required such anchorage in classical traditions. The new illustrated weekly journals, for example, routinely included sections on science and technology, and technological education had moved to the industry involved, which developed advertisements in the form of educational magazines.<sup>3</sup> Weimar Germany’s cultural theoreticians Georg Simmel and Siegfried Kracauer (1998) noticed the emergence of the office worker as a new type of well-educated, technocratic employee, while Benjamin (1969) celebrated technology and new media as the means to turn every member of the public into an “expert” of his or her own specifications.

### **An industrious career**

The *Man as Industrial Palace* poster was originally designed as the special offer for those *Naturfreunde* members who had subscribed, in 1921, to a five-volume popular anatomy and physiology of the human body (Kahn, 1922-1931). Prolonged by the inflation crisis of 1923 and the economic depression at the end

of the 1920s, but also by the difficulties of containing the increasingly extensive material in the initially planned volumes, the book finally amounted to more than 1,600 pages, with the last of its 50 binders issued and distributed in 1931, a decade after the start of the project. More than a thousand illustrations were included in the five volumes, and almost 150 colour plates. The exact number of printed copies of the different volumes is unknown because of the different publication channels, but its widespread availability in public as well as academic libraries and at antiquarian bookshops suggests a high number. In all likelihood, the book represented the biggest publication project to follow the pathways of the *Naturfreunde* society.

The author of this five-volume book was Fritz Kahn, by then a well-established science writer and *Kosmos* contributor. Fritz Kahn had finished his university education by training as a medical doctor and settled in Berlin with a private practice as a gynaecologist before he published his first book for the *Kosmos* series in 1914, a slim volume on the Milky Way (Kahn, 1914). It was the starting point for an internationally successful career as a popular science writer; his second volume in the *Kosmos* series on the cell from 1919 was translated into English within four years (Kahn, 1923). During the years of the Weimar Republic, Kahn also wrote regularly on science and medicine for the *Berliner Illustrierte Zeitung*, Weimar Germany's most widely read weekly, and for other publishers. By the time of his death in 1968 at 80 years of age, Kahn had written more than a dozen books, most of them translated into several languages (often English, Dutch, and French; less often also Spanish, Portuguese, and Italian; and some even Chinese, Indonesian, and Finnish). Kahn wrote primarily on medical topics, with an emphasis on sex education. Titles such as *School of Happiness in Love*, *1000 Answers to 1000 Questions*, and *Must Love Always Be Blind?* attest to his talent for converting experiences from his practice into common knowledge and demonstrate his publishers' noses for profitable production lines. Occasionally, however, Kahn also wrote on as different a topic as nuclear physics, advertised as the "basic facts for citizens of the atomic age" and published with Albert Müller in Switzerland in 1949 (Kahn, 1949), or on the *Design of the Universe* (Kahn, 1954).

It is likely that Kahn had returned to Europe from his U.S. exile by 1949, but surprisingly little is known about the biographical details of his life. As a Jewish physician, he had to close his practice in Berlin in 1933 in concordance with new racist legislation. Reports conflict, however, about how and when exactly he arrived in the U.S. after fleeing Nazi Germany, probably via Switzerland (where one of his publishers had moved), France, and possibly Portugal in 1940 (Sternfeld & Tiedemann, 1970). His two last books before his emigration to the United States, *Our Sex Life* (Kahn, 1935; Kahn, 1939) and *Man in Structure and Function* (Kahn, 1940; Kahn, 1943), still appeared in Leipzig, Germany, in addition to their publication in Zurich, Switzerland, and both were quickly published in English translation by Alfred Knopf in New York. Both books appear to have successfully entered the American market, as many newspapers reported on them. *Scientific Monthly* ran advertisements for *Man in Structure and Function*, and Ralph W. Gerard, later a prominent neuroscientist and participant at the Macy

conferences on cybernetics, criticized the book in the magazine as an unbalanced concoction of both helpful and misleading information that would only make its way because of its illustrations:

The book will probably be a success—lovely pictures, positive answers to the sort of questions laymen are wont to ask, an aggressive promotion—almost insure it. But the reader will be entertained more than instructed. (Gerard, 1943, p. 178)

*Our Sex Life* was reviewed in the *American Journal of Psychology* and the *American Sociological Review*, *Man in Structure and Function* in *Quarterly Reviews of Biology*. Both books were reprinted several times. Apparently, body and sex sold. Kahn's latest book so far, printed ten years after his death, was the Dutch *Het seksuele leven en de jonge mens* (Kahn, 1978).

### A picture industry

Most of Kahn's books were lavishly illustrated and usually also included a selection of coloured plates, but so were the books the *Franckh'sche Verlagshandlung* produced for the *Kosmos Gesellschaft der Naturfreunde*. As will be described in this section, the style of visualization was not so much an individual artistic signature as a carefully developed and maintained company product. The images were the product of collective authorship to a far greater degree than simply required by the always necessary collaboration between writer, draftsman, lithographer, and printer. Among the more than 1,500 illustrations, images, and tables in the five volumes of *Das Leben des Menschen*, at least a dozen different illustrators can be identified. I will simply speak of "Kahn's visualizations" when referring to the images in general, because further clarification about authorship remains a questionable desideratum in this case. Instead of speculating about Kahn's possible influence on the visualization strategies or his intentions with the graphic design of his books, the historical fact of a blurred authorship appears to be more significant and particularly relevant to the discussion here, as it refers to a collectively constituted and discursively stabilized author-subject, reminiscent of Michel Foucault's famous essay "What Is an Author?" (Foucault, 1977). Its collective nature turns this specific mode of visualization into a culturally important artefact as it was shaped by larger historical circumstances. They obviously provided the repertoire of technological gadgets necessary for many of the comparisons; in addition, the new economic potential of science popularization in the Weimar Republic offered a physician like Kahn a career alternative, and finally the professionalization of graphic design in a large publishing house like *Franckh'sche Verlagshandlung* allowed the development of a highly distinctive style—to name just some of the more important factors contributing to the final product.

The collective nature of the book's illustrations can be examined further by comparing Kahn's monumental *Das Leben des Menschen* with his earlier *Die Zelle* and with later publications in the *Kosmos* series by other authors, such as a booklet on hormones from 1933 (Venzmer, 1933). The most obvious difference in this sequence is the very limited use of visuals in the earlier book. *Die Zelle* has only 9 illustrations in its 65 pages, most of them simple drawings of small size, directly inserted into the text. This contrasts with roughly a doubled number

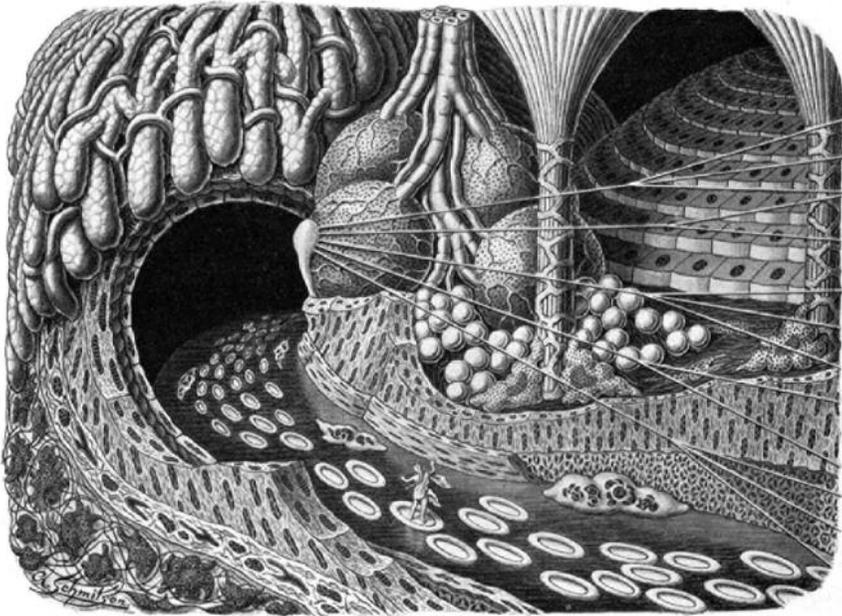
in the later booklet and even more strikingly with the hundreds of large and sophisticated illustrations that characterize every volume of *Das Leben des Menschen*, in addition to the often more than 30 tables per book, some of which were in colour.<sup>4</sup>

More interesting than sheer numbers is the style of the images. The 1919 volume already comprises images of different media and drawing types (photos, schematic and illustrative drawings), but none shows any comparisons with technology or machinery. Some develop a form of imaginative histological landscape drawing that would occasionally return in *Das Leben des Menschen*, but most of the illustrations are fairly simple. The *Kosmos* booklet from 1933, in contrast, not only contains more photos—thus reflecting how the industrial perfection of photographic reproduction and printing technology made this process cheap enough for this market segment—and none of the poor schematic sketches that characterized the drawings of the 1919 booklet, it also has several large-scale images that show the metaphoric and technological visualization style typical of *Man as Industrial Palace*. In the case of the book on hormones, for example, streams of trucks and trains pass through the industrial plant of the thyroid gland. *Das Leben des Menschen* forms part, in this sequence, of a transitional period during which the publishing house, probably in collaboration with its authors, invented this new, modern, and abstract-realist form of visualization, a technological type of illustration that was then moulded and branded to a particular style.

This inspection thus already yields two important results. First, the role of images advanced from being of marginal, supplementary relevance to serving as an integral part in the overall explanatory strategy. The other important aspect is the involvement of the publishing house's entire graphics department in this process. Fritz Kahn's *Das Leben des Menschen* is distinctive in its style of visualization, but these illustrations were produced by several artists, draftsmen, illustrators, and graphic designers. Apart from a professional anatomical style of illustration, several forms of realist-narrative modes can be identified and differentiated. Some are more neo-romantic or art nouveau, reminiscent of Ernst Haeckel's images demonstrating Nature's organic beauty; others are more surreal and in line with the modernist avant-garde or the new *Sachlichkeit*. Some of the originals for these images were recycled from Kahn's earlier books, while others were redrawn (often in a strikingly similar form) even for a second or third print run (see Figure 2).<sup>5</sup> Some of the names of artists and their respective styles can also be linked to books by other authors in the *Kosmos* series, thus demonstrating how the graphic design of the books lay in the hands of the publishing house, leaving to Kahn hardly more than a general preference for a more functional-technological and less morphological aesthetic. This functional-technological style was apparently embraced by the publisher and later disseminated to several other publications within the series, as the later booklet on hormones shows.

This transition can be observed in more detail if we examine the individual volumes of *Das Leben des Menschen*. The fully developed technological style appears only in the second volume, as, for example, in an image illustrating the technical, structural, and functional similarities between electric circuitry and the nervous system (see Figure 2). One version of this drawing is signed, and the





Einfahrt in eine Drüsenhöhle mit idealer Zellenlandschaft.

**Figure 3: A fairy-tale landscape, mixing stylistic elements from art nouveau and neo-romantic organicism and illustrating how a migrating cell enters a gland [*Einfahrt in eine Drüsenhöhle mit idealer Zellenlandschaft*] (Kahn, 1922-1931, Vo. 2, table 26)**

ble to disentangle with regard to an accurate determination of Kahn's role or influence; the very attempt to do so would fail to recognize the crucial importance of the interplay of these manifold forces. "Kahn" is the product of his times. The vagueness of any personal information related to his name only highlights further what must be regarded to be the main insight from the investigation of the visualization strategies at work in his publications.

### **The branding of an industrial product**

The interplay of science writing, image making, and book production in the Kahn collective of authorship can be elucidated further by the books developed for a new, international market. The dynamics at work here appear to have exerted a continuous recursive reinforcement, accentuating a particular strand among a variety of options in a positive-feedback process until a style emerged that Kahn successfully branded and copyrighted for his English editions. By 1931, with the completion of *Das Leben des Menschen*, Kahn had accumulated a large stock of visual material. Given the frequent recycling of images that can be traced to different editions of the volumes or between *Die Zelle* and his later works, it may hardly be surprising that Kahn reused many of the images also for his later books and translations. This applied in particular to *Man in Structure and Function*, the English translation of *Der Mensch gesund und krank*, which was something like

a two-volume abridged version of the original five-volume set, now printed as a regular book with the Swiss-German publishing house Albert Müller. The vast majority of its several hundred illustrations were simply reprints of images from the earlier *Das Leben des Menschen*. How this became possible, legally as well as technically, is not clear. From the circumstances it must be assumed that Kahn possessed, or had access to, most of the originals for the images.

Precisely the overlap and recycling of imagery between the various books and translations makes the differences stand out all the more. Compared with the original sample and its heterogeneity, the images selected for the English translation showed a clear preference for the technological mode of visualization. The style of visualization with which Kahn was introduced in America was thus much more coherently developed, compared with his more varied publications in Germany.<sup>6</sup> The images stood out; they were the distinctive mark that every reviewer mentioned and that still serve as the main feature of Kahn's books. Their originality lay in this spectacular mode of visualization, as the *Quarterly Review of Biology* wrote:

The most noteworthy feature of the publication consists in its 461 well reproduced illustrations, many of which are highly imaginative and most are instructive to a rare degree. At times, however, the desire for originality has gone to almost absurd extremes and some illustrations interpret the facts in a distorted fashion. . . . In spite of its many shortcomings, the work is to be recommended to laymen and even to medical students and this particularly on account of the great number of novel and stimulating illustrations. ("Review of *Man in structure and function*," 1943, p. 385)

The distinctive style of visualization furbished the book with a high degree of recognizability and constituted it as a genuine product. The imaginative style of the illustrations helped to secure the book's economic success, and in so doing, the book turned into a stylish product, an item that sold, a commodity. Out of popular science education emerged a type of visual product that reflected social-economic factors as well as commodity aesthetics. While the varieties in visualization that were characteristic of Kahn's German books testified to the involvement of many hands from the large graphics department of a specialized publishing house and equally to the various visual regimes in the culturally highly fractured Weimar Republic, the production of the English translation appears to have functioned as a kind of gating mechanism, streamlining most of the original and originally contradictory heterogeneity in visualization into a coherent style, furbishing the book with a new integrity and commodified identity. The American market had determined the book in a new way.

This moulding of the book and its images into a product further blurred the boundaries between the individual contributions from the author and the team of illustrators, which had not been well defined from the beginning. The originally distinct styles melted into a trademark that Kahn successfully branded, if one may apply the term anachronistically but tellingly and pertinently (Stern, 2006). In most of the illustrations in *Man in Structure and Function*, the signature of the illustrator (whether there was one or not) had been replaced by the stamp "FK©," copyrighting the work to Fritz Kahn. This usurpation of originally foreign mate-

rial may have been forced upon Kahn by the different copyright rules for graphic material in the U.S., compared with Germany. This assignment of large-scale authorship by means of a stamp, however, turned the branded items into industrial products, and “Kahn” moved from the author position to that of a brand; “Kahn” became the name attached to a collectively stylized enterprise.

Applying a Benjamin-like dialectical cultural analysis here, one could argue that this brand name reveals an additional layer of historical truth in these images. The stamp refers, first of all, to the modes of technological reproducibility that made the copyrighting of the images necessary and possible, and hence indicates a significant shift in the form of authorship, requiring new forms of protection. In doing so, in procuring legal authorship for the visuals, however, the stamp literally crossed out and deleted the last remaining traces of physical authorship in the collaboration of artisans so typical for the printed image. The stamp attributed the images to an individual name, precisely because they were the products of a modern, collective, and anonymous bureau in graphic design. This new mode of production had replaced the traditionally manufactured article representative of anatomical drawings and prints from Andreas Vesalius to Henry Gray (Harcourt, 1987; Kemp, 1993; Kemp, 1998). The new images originated literally in the production studios and workshops that were so often depicted on them and where the new type of the *Angestellte*, of white-collar worker, made his money. They were calculated, designed, formed, and printed according to the very same principles of technological rationality, economic efficiency, and bureaucratic anonymity that lay at the core of the visualization strategy and that had just started to shape Western societies. The stamp thus executed what the images always already showed: their derivation from the rational division of labour and the instrumental reason of industrial modernity.

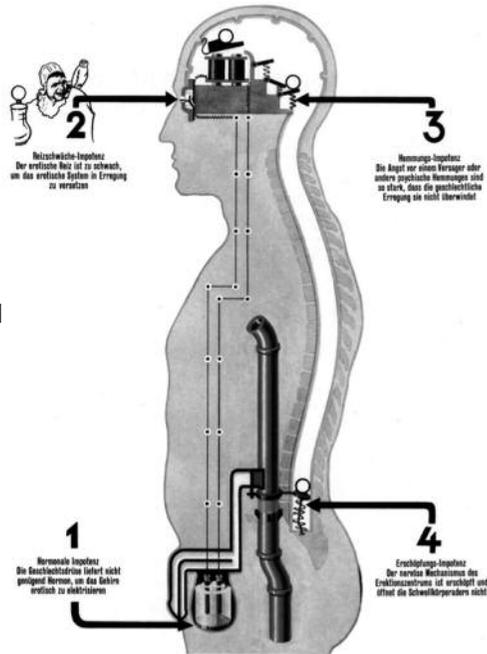
### **Gendered industrial anatomies and their limits**

The branded style of the FK© product line was certainly not monolithic; it still comprised a variety of illustration forms and visualization modes. But the analysis of Kahn’s visualizations as the formation of a branded product also sheds new light on old differences, and in particular on the narrative-realist mode of representation that harked back to art nouveau and organicism. This style persisted side by side with the technological style and was slightly modernized (for example, the resonances with fairy tales were abandoned), but more and more it was reserved for representing the organic as the non-technological. Following this process, the two modes of representation acquired clear-cut gender stereotyping, as is demonstrated starkly by some of the illustrations from *Our Sex Life*. When dealing with so delicate a topic, the plain and sober rationality of technological realism had much to offer. For example, it enabled the author and the publishers to include illustrations that were more than schematic sketches without running the risk of making the book pornographic.

The techno-realism afforded the illustrations a remarkable concreteness and degree of detail, in particular where the intricacies and complications of the functions of the male sexual apparatus were visualized (see Figure 4). This was a complicated technical apparatus where levers, sensors, controls, and regulators all had to work in unison to keep the fragile ensemble going. The female coun-

terpart, in contrast, was still labelled a “sexual apparatus” but depicted as a monstrous creature halfway between polyp and dragon. Among its sinister organic clutches, there was no place for technical failures, but also no room for techno-

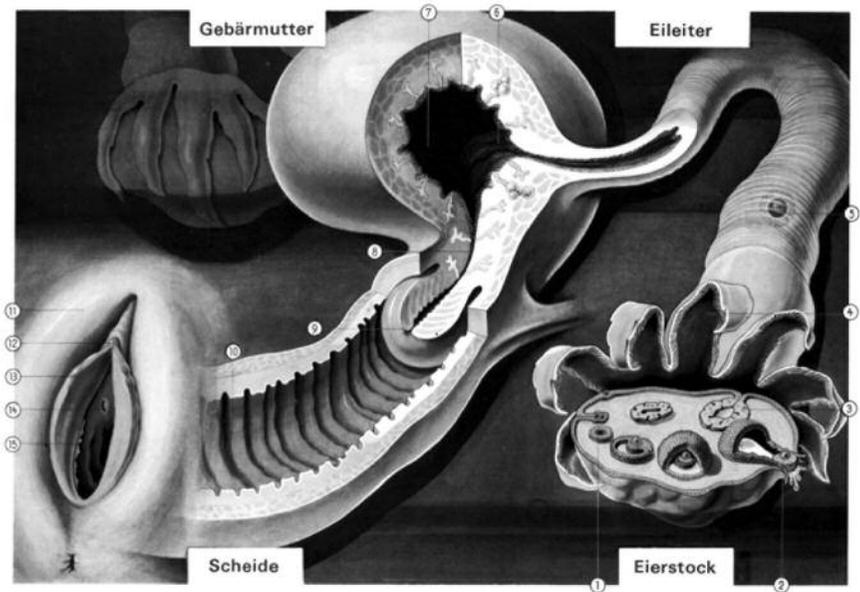
**Figure 4: The “male sexual apparatus” depicted as delicate electromechanical machinery for explaining various causes of erectile dysfunction (Kahn, 1965, table 20)**



logical mediation (see Figure 5). The female was represented as that which resisted the very process of technological acculturation that drove this mode of visualization. As a consequence, it fell, by and large, out of the visualization mode of the FK© product line. Almost all of the human beings depicted in Kahn’s many illustrations were either explicitly male or allegedly sexless standard bodies (and hence male); in particular, all the little operators at the internal controls and switchboards were depicted as male assistants, in some contradiction to the social reality of the 1920s, when switchboard operators, for example, were typically women. The second version of *Man as Industrial Palace* is exemplary in this respect because it further underlines the gender stereotyping. Close scrutiny reveals that the system that most clearly resembles a telephone switchboard and that is located in the region of the brain stem (where the most basic nervous connections are made) is shown as operated by women. All other control functions (e.g., all higher control and decision-making) remain in the hands of male operators.

This gender bias of female organic monstrosity *or* feeble beauty versus male rational technology *and* powerful intelligence was so deeply engrained in Kahn’s visuals that these images and the economic success of Kahn’s books give strong testimony to the persistence of traditional gender stereotypes about nature well into the twentieth century (Schiebinger, 1993). This was, however, hardly the fail-

ure of Kahn or his publishers alone. In fact, in depicting nature in this stereotyped way, the images reveal as much about the social nature of this knowledge. Popular images such as these provide important evidence for the gendered history



**Figure 5: The gendered limits of the technologized body: The “female sexual apparatus” visualized as monstrous creature (Kahn, 1965, table 7)**

of scientific knowledge. They demonstrate—in the sense of visual testimony—how technology provided access to the body and how this imposed a male standard upon it. The gendered stereotypes in Kahn’s images are the epiphenomena of the intrinsically male conceptualization of the human body. Technology opened the human body under the disguise of a unisex universality, and Kahn’s images expose not just the male dominance at work here, but its conceptual blindness (Creager, Lunbeck & Schiebinger, 2001; Kohlstedt & Longino, 1997). The inability of the visualization strategy to provide an adequate technological analogue for the female reproductive “apparatus” was more than a mendable inaccuracy or a problem in communication about the human body, significant primarily for historical curiosity; it signalled an epistemological collapse that was to foreshadow biomedicine’s lasting failure to arrive at a comprehensive understanding of the human body’s gendered diversity.

### **The history of an explanatory strategy**

Regardless of these problems and gender stereotypes, how was the visual strategy of aligning bodily functions with technological processes supposed to work? The image from above comparing electric and nervous circuitry (cf. Figure 2) provides a good entry point to the discussion of the general explanatory strategy of depict-

ing bodily functions as technical operations. The analogy itself was hardly new. The comparison of a nerve with an electric cable goes well back into the nineteenth century to a time when electrophysiology and the electrical industry co-emerged—for example, when Siemens & Halske, a giant of the electrical industry in Germany by the turn of the century and forerunner to the now globally active Siemens company, made its first profit from the constructions Johann Halske had developed in the physiological laboratory of Emil du Bois-Reymond in Berlin (Dierig, 2006; Lenoir, 1994). In fact, electrophysiological experimentation had been decisive in the development of sensitive equipment for use in the national and international telegraph networks. Further refinements, such as electric amplification as required for the trans-Atlantic cable, were quickly fed back into and opened new avenues of exploration within electrophysiology, this time enabling the registration of the electric underpinnings of the heart's beat in electrocardiography (Borck, 1997). Given these multiple and complex interconnections, speaking of telegraphy as “a nation's nervous system” or of its centre as its “brain” may still be counted as metaphoric. But when this expression—and also the reverse, speaking of nerves as electric cables and of the nervous system and the brain as the central office of a telegraph system—became a trope in late-nineteenth-century discourse, this reflected their extensive material interconnectedness.

Given the particular concern of nineteenth-century debates for time and historical processes, it may not be surprising that such analogies were integrated into evolutionary accounts of the history of technology, into a philosophy of technology that traced all technological inventions back to biological analogues. For Ernst Kapp, the German philosopher and life reformer and American spa operator, these similarities proved that technology in general was nothing but an unconscious externalization of the body's intrinsic principles of operation, an “organic projection,” as he called this mechanism of technogenesis. As a consequence of this process of externalization, however, the technological principles, and thus the biological operations of the body, became accessible to manipulation, intervention, and scientific exploration, setting into operation a process of open-ended perfection that would gradually become more abstract and detached from its organic origins:

The organic projection succeeds triumphantly in the case of telegraphy. All its main characteristics, the unconscious fabrication following an organic pattern, the encounter between original and double by way of analogy, the conscious realization of their congruence and the perfect harmony between organ and instrument in all conceivable ways; all these steps have come to light in the case of the telegraph system with extreme clarity. (Kapp, 1877, p. 140)

By 1877, not everyone readily accepted Kapp's evolutionary theory of culture and technology, but the mutual reference between the nervous and telegraphy systems had become a commonplace to such an extent that psychologist Wilhelm Wundt lamented about “this frequently used metaphor” in his *Grundzüge der physiologischen Psychologie* (Wundt, 1874, p. 346). Almost a hundred years later, when Marshall McLuhan digested the impact of the electrification of vision into his media theory, he reiterated Kapp: “With the arrival of

electric technology, man extended, or set outside himself, a life model of the central nervous system itself" (McLuhan, 1994, p. 43).

This theory of the life model appears to be illustrated in Fritz Kahn's figure (cf. Figure 2). The image shows two electric circuits, one in the outside world driving the bell, the other inside the body driving the hand pushing the knob. A numbering system, referring to identical parts by the same number in either a circle or a triangle, spells out the analogy in five parts, from number one referring to the trigger (knob/visual image), via number two, the energy source, number three, the wire/nerve fibre, number four, the electromechanical transmitter, to number five, the moving lever/finger.<sup>7</sup> At this point, however, the image illustrated common strategies of speaking about the body in technical terms in the form of a graphical explication of these comparisons or analogies, but it did not mobilize the technology to directly replace the body function. The electric magnet pushing and pulling the lever is depicted right next to the muscle and nerve, but it is still the biological muscle and not its electrotechnical counterpart that moves the finger. The double-numbering system aligns the organic and the technological side by side but leaves each intact, and in this regard the image does not yet employ the technological visualization style of the *Industrial Palace*. This strategy is reserved here for depicting what is going on in the brain, where room-sized switchboards stand in for the respective centres of volition and execution.

The explanatory strategy, however, has been reversed. While Kapp and McLuhan speculated about possible ways of deriving technology from the body, Kahn employed technological artifacts from daily life in order to elucidate hidden and invisible functions within the human body. Instead of "organicizing" alien technology by recourse to the body, the image familiarized the body's alien organic inside by recourse to common gadgetry, as if a form of techno-literacy would bear the potential to re-connect with the body's machinery in new ways. The familiarity of the beholder with the technology depicted served as an entry point into the mechanizations of the human body. Not everyone knew exactly how to operate a switchboard or other machines depicted, but seeing them as being operated by human fellows secured the possibility of explication. Looking back at these images from the distance of three-quarters of a century and from the transition into the postindustrialized global world, one may smile at the naïveté or simplicity of the technological solutions these images visualized and promised. *Man as Industrial Palace* depicted a technological paradise that misrepresented biological bodies as it measured them by rather humble technical artifacts.

In retrospect, the alignment of cognitive control with something as dull and limited as a switchboard seems hardly more ingenious. The telegraph office was soon to be replaced by the computer and, after the arrival of the Internet, by interconnected, parallel computing. The technological modernism of the images underlines their datedness today. Since no biological structure ages as quickly as obsolete technology, the images helped to situate the depicted social reality in modernity. Only this double modernity of technological innovation plus social adaptation provided the cultural framework for depicting the human body as a culturally decipherable object. In the visual language of this and similar images, human beings finally managed to understand themselves and to reveal their iden-

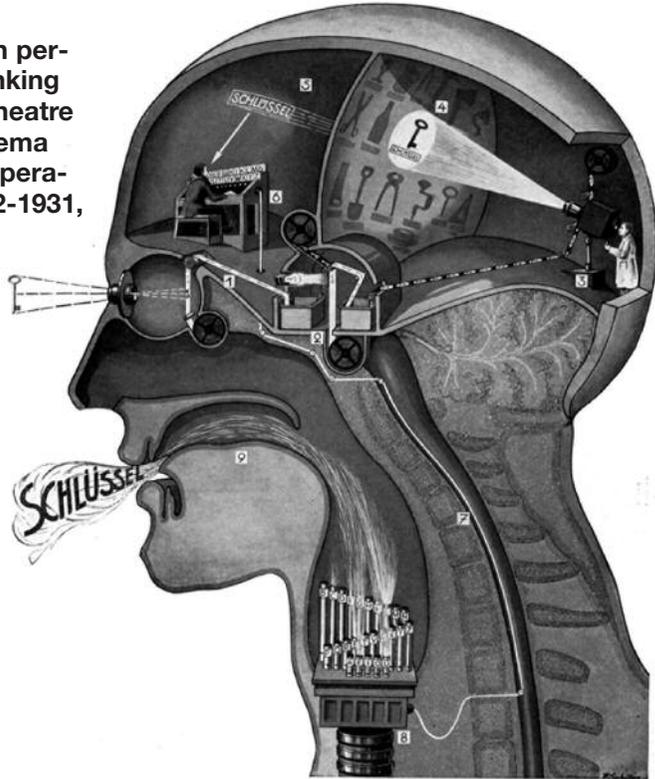
tity by the construction of industrial technology. If Kahn's visualizations are dated, it is not because of the obsolescence of the technology depicted, but because of the harmonious integration of the technological and the social that serves as the ultimately stable frame of reference for their explanatory potential. With the unmasking of universal humanist rationalism as the partial and particular viewpoint of White male Westerners, little seems left of Kahn's vision.

### **Man-machine doubles**

In following Kahn's strategy of educating about human physiology through its radical amalgamation with culture and technology, nothing appears to be as powerful as modern communications and media technology. Kahn's total congruence between human nature and culture, where one side provided the key for the other, however, had already collapsed during his lifetime—and in the images themselves. In replacing a biological structure with a technological structure, the graphical elucidation became at the same time explicit and opaque; the explication of human conscious action by the technological analogue of a communication technology remained curiously incomplete. Whatever the switchboard stands for, the output remains, in fact, the consequence of the doings and actions of the two operators. These homunculi are the ultimate actors, even though they may be said to simply follow instructions. The visualization strategy thus ended in two equally disastrous alternatives. Either the images revealed human beings to be little more than the slaves of their bodily machines, or they explained nothing and only shifted the problem to the level of the homunculi, who replaced human beings as centres of decision and control. On a more general level, one could as easily argue that the technological reductionism depicted here was itself already outdated, regardless of its borrowings from the cinema. Physiological research—and Dr. Fritz Kahn had finished medical school as late as 1912—had demonstrated biological control to be much more complex and self-regulating than obeying fixed mechanical settings, for example.

A final image demonstrates this point more clearly as it moves away from the overused telephone and telegraph metaphors (see Figure 6). The image shows once again a process of visual perception and its translation into action, but this time not as pushing the knob of an electric bell, but as the uttering of a word that denotes the object perceived (a key, of all possible things, of course). Here, seeing and listening are explained by likening them to a form of a cerebral cinema with electric organ music. As a first result, the image extends the arsenal of telephone operators and system administrators to the organ player and film projectionist. On another layer, the image participates in the cinema culture of the 1920s, buying into its vibrant dynamic to channel some of this energy into science education. The new audiovisual culture of the cinema, driving human sensory perception into hitherto unknown realms during this period, is mobilized as an example of what is explained to go on in the head, as if the truth were to be found in this holy communion of technologically mediated experience and bodily functioning. The analogy of the mental radio and cinema appears to be more telling with regard to the new reality of Weimar Germany's cinema industry, as if Kahn was "calculating with the wit of the audience," as Benjamin explained in his review of a Berlin health exhibition (Benjamin, 1972, p. 557f).

**Figure 6: Human perception and thinking as new media theatre with mental cinema requiring little operators (Kahn, 1922-1931, Vol. 4, table 8)**



It would indeed be very easy to denounce Kahn's images on grounds of their many shortcomings and limits. A recent re-edition of the poster by the Museum for the History of Medicine in Bochum, Germany, comments accordingly:

The reductionism of its explanatory strategy opens only a one-dimensional perspective upon human beings. The chance to depict human beings truly as industrial plants and thus to mark the limits of the paradigm has not been taken. (Schulz, 1996, p. 4)

What explains an image that does not lead any further than to introduce miniature operators into its world of automata and machines who do exactly what the technology is said to do? Given that the many little assistants in Kahn's images do their work so diligently and smoothly right out in the open of the image, however, it seems too simple to base a critique of the visualization strategy on their existence there. The mere fact of the comparison of human beings and their organs with machines may have certain limitations and shortcomings, but this alone is not yet a sufficient argument against this long and firmly established strategy:

Comparison of living things with machines may seem at first to be a crude, even rather childish procedure, and it certainly has limitations: but it has proved to be extraordinarily useful. Machines are the products of our brains and hands. We therefore understand them thoroughly and can

Speak conveniently about other things by comparing them with machines. The conception of living bodies as machines, having, as we say, 'structures' and 'functions', is at the basis of the whole modern development of biology and medicine. (Young, 1968, p. 22)

Speaking at the height of the cybernetics frenzy, the British biologist J. Z. Young defended the machine metaphor as a useful tool and, in fact, as the most widespread strategy to explore unknown organic structures. The machine analogy may still be naïve or full of limitations, but at least it has proven to be successful in the life sciences; without doubt it possesses a heuristic value.

Up to that point, Young had used a strategic or pragmatic argument when evaluating the problematic strategy on the basis of its success in the sciences. But a few pages later, he turned the same argument into a fundamental epistemological analysis:

People who have not thought carefully about the use of analogies are apt to take them too literally and to think that by comparing something with something else you can in a subtle way grasp, as they say, what it *really* is. This belief in the magic of comparison and of words has indeed a certain justification. . . . The point is that comparing something unknown with something already known makes it possible to talk about the unknown. (Young, 1968, p. 31)

The question is not whether the strategy has limitations or where exactly these limits are; all technological analogies capture only specific aspects and not the object in its entirety. But Young's fundamental argument is that only this quasi-magical mis-identification of a biological object with a technological structure opens it up to experimental exploration. According to Young, access to the human body as a biological object is possible only via the detour through technology.

Independent of the validity of this argument, Young thus provides a surprising key to Kahn's visualizations. Whatever their advantage or limitation, Kahn's images visualize exactly the strategy of the life sciences as described by Young—and they do so with a double gain. On the one hand, the images illustrate this strategy so accurately and faithfully that they visualize the failure of the strategy, wherever recourse to little assistants or to external, unmediated sources of energy and information becomes necessary. Contrary to the Bochum commentary, one should rather argue that the images follow scientific reductionism to its ramifications, where the limits of the one-dimensional perspective on human beings become painfully obvious. In the attempt to depict human beings truly as industrial plants, the poster visualizes the limits of the paradigm—what else do the homunculi indicate?

On the other hand, the images heighten the common comparison of bodies and machines to a manifest amalgamation of nature and technology. The images thus visualize a constructivism in which technological civilization and experimental science intervene in the biological nature of human bodies. The ambiguity of their iconography provides the key to how nature coagulates in the contraction of the social and the scientific into a cultural construct. This interpretation of Kahn's images is independent of his own insight into such matters or his lack of proper training in the sociology of science. Precisely because Kahn took his mission to

educate the public on the human body so seriously, he invented, in co-operation with an ambitious publishing house, powerful and hence ambivalent visualizations that reveal their own limitations so clearly. Kahn's visualizations appear to be totalizing explanations, but they are incomplete; they visualize precisely how knowledge proceeds pragmatically and thus progresses historically. The images visualize knowledge together with the open questions that come with it, the traces of the optical unconscious of techno-medicine and machine philosophy.

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### Notes

1. The illustrations in this article come from two German books by Fritz Kahn which, according to information from the publishing houses, are out of print and the publisher's copyright has fallen back to Fritz Kahn or his family. Kahn died in 1968, and the publishers were unable to provide me with viable coordinates.
2. For historical information on the publishing house, see their website, <http://www.kosmos.de/index.htm> [October 30, 2006].
3. The *Siemens* company, for example, Weimar Germany's leading electro-technical industry, sponsored *Wissen + Fortschritt*, a monthly magazine celebrating technological progress alongside advertisements, camouflaged as detailed articles, for household appliances such as electric irons with thermostats.
4. It must be taken into account, however, that *Die Zelle* was produced in 1919 as part of what was labelled "the war edition," a continuation of the *Kosmos* series under economically difficult circumstances. Indeed, a discrepancy between the number of illustrations—nine—and their printed numbers (1 to 22c) adds further evidence that the printed version deviated from the original publication plan because of adverse circumstances.
5. Douwe Draaisma has argued that Kahn aimed to update his book by redesigning the illustrations for every edition to the most recent trends in fashion and industry (Draaisma, 2000). As fascinating as this argument is, Kahn's recycling of images, often over decades, points to rather different reasons, such as practical circumstances or copyright questions.
6. Kahn's *The Cell*, the English translation of one of Kahn's earlier books, does not seem to have had a strong impact there.
7. Whatever the explanatory value of the image (it may serve best as simply an impressive image, sticking in one's memory and thus helping to memorize the statement of the nerve/cable identity), a few oddities or curious details, such as the telescope in the brain and attachment of the battery to the head, should at least be mentioned.

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