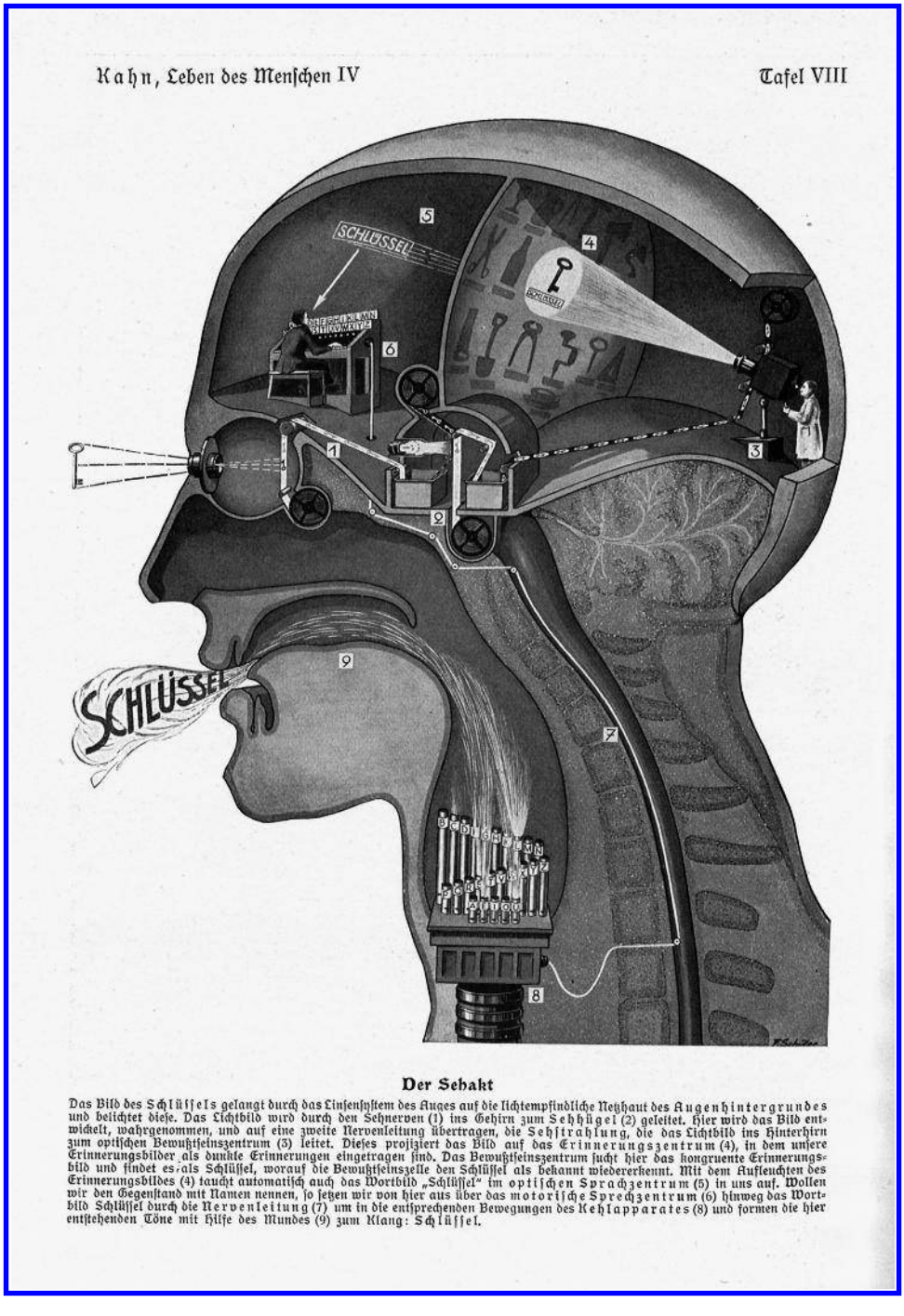
"The act of seeing." From Fritz Kahn, *Das Leben des Menschen*, vol. 4 (1929).



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Recording on Film, Transmitting by Signals: The Intermediate Film System and Television's Hybridity in the Interwar Period

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In 1928, Telefunken (a major German telecommunications corporation) prepared two technological novelties for the visitors to its exhibition booth at the Funkausstellung, the annual radio fair held in Berlin. Materializing "the future" of the radio industry, the two exhibits promised new ways of seeing and hearing "at a distance."[1] The "television Karolus" (named after its inventor, August Karolus, who had developed the apparatus in collaboration with the corporation's laboratories) was praised as "the ultimate stage in the development of picture telegraphy."[2] Its transmitter allowed the broadcasting of slides and film excerpts via wire over a short distance. On the receivers' end, the visitors saw a screen eight-by-eight centimeters in size, as well as a projector that could enlarge the televisual image up to seventy-five square centimeters.[3] "This is how pictures can be made accessible to a certain number of persons at a time," a German scientific journalist wrote for the British journal *Television*.[4] In the immediate vicinity of this technological attraction, a second experimental machine was exhibited: the *Gleichlaufkino* (synchronized cinema). This invention added a visual element to radio broadcasting by allowing its users "to show the same movie simultaneously in any number of places and in exact synchronicity with the acoustic component."[5] Standing in front of a microphone and a cinema screen, a lecturer provided a live commentary on the projected silent film. His speech was transmitted wirelessly to the affiliated movie theaters showing the same picture.

The two devices' spatial contiguity within Telefunken's exhibition halls reflected their common origins in the scientific and industrial laboratories of their parent corporation and demonstrated their conceptual proximity. Both machines were hybrid and heterogeneous artifacts whose media identity was not characterized by specificity but by conceptual "impurity" and tech-

nological assemblage. The Karolus television, compared in the press to picture telegraphy, transmitted prerecorded still or moving images and was designed for individual and collective reception. Also called "Fernkino" (telecinema), its various features relate only vaguely to the commonly accepted definition of television as a domestic medium for (live) transmission at a distance.[6] Similarly, "synchronized cinema," located on the frontier between silent and sound film and already obsolete when displayed for the first time, combined the recorded film image with the presence of a radio voice.[7] The voice-over complementing the projected image guaranteed the immediacy of the performance and, through its broadcast to affiliated movie theaters, created a "live" audience participating in an event exceeding the single theater's walls. Both devices thus transgress the borders of familiar media genealogies—film, television, radio—and question the antagonism of paradigmatic pairs implicitly or explicitly present in many media definitions. The concepts of storage versus broadcasting or recording versus immediacy, employed to differentiate archiving media (photography, cinema, gramophone) from live media (telephone, radio, television), converged in these devices at both technological and conceptual levels.

Historians of technology have argued that the categories of success and failure regularly applied to similar apparatuses are two contingent and ambiguous notions. In his essay on technological "flops," Graeme Gooday points out how, over time, a so-called failed technology could become a successful one and vice versa; how a successful apparatus could become economically unviable; and how failure is sometimes a necessary step toward a successful solution. By disturbing the seemingly simple classification of "good" and "bad" devices and technological systems, Gooday reveals the social character of success. "Completely embedded in the social relations of its usage . . . the category of 'success' is a thorough-going *social construction*," depending not on technological "hardware" but on the people, institutions, and corporations making, regulating, distributing, and using the machine.[8] In a different theoretical and disciplinary tradition, but with quite similar agendas, media archeologists argue that "dead media" and failed or imaginary technologies are just as important for a history of communications as the so-called successful machines.[9] Unearthing "the significance of historical evidences that are usually disregarded," the archeological perspective on media history allows us to expose the "topicality of what has passed" by uncovering alternative histories echoing contemporary issues of

Exhibition of television and "synchronized cinema," Berlin, 1928. From *Telefunken-Zeitung* (October 1928).

media convergence and hybrid media identities.[10]

Drawing on methodological and theoretical frameworks informed by media archaeology, this article aims at exploring television's hybridity and interdependency with other media—in particular cinema, photography, and print—by analyzing a third apparatus developed in Germany under the name "das Zwischenfilmverfahren," the "intermediate film system."[11] Originally patented in the United States by Bell Laboratories in 1927, the system was improved by the German-British Fernseh A.G., who operated it during the 1930s.[12] Combining essential components of film and television technology, the intermediate film system challenges "'canonized' narratives" confined to hegemonic media forms and offers an eloquent example of the manifold links existing between media practices, discourses, and technologies.[13] Instead of opposing "cinema" and "television," "photography" and "radio," this essay seeks to highlight the fluidity and permeability of these media and their respective histories.

Starting with a description of the intermediate film system's technological design, I address the question of its relationship to other media from three complementary perspectives. Without drawing a complete picture of the device by covering every aspect of its history, my approach attempts to project a mobile cartography of links and affinities between multiple machines and their stories. First, through an analysis of discourses and objects, I show how technological and conceptual "impurity" is not specific to this particular televisual device. Contemporary sources, proposing open and nonessentialist definitions of television, recurrently challenged the paradigm of immediacy as a fundamental aspect of television. Second, I extend my analysis of television's hybridity to the works of Fritz Kahn, author of popular science books reflecting a rich and multiform media universe. Kahn's drawings serve as a starting point for discussing the circulation of categories such as instantaneity and archiving, recording and transmission, and will confirm the existence of a televisual imaginary that went beyond learned debates among specialists. Finally, I analyze the convergence of television and cinema at the core of the intermediate film system from economic and industrial perspectives, explaining the advent of this device as part of the modern culture industry. Developed by a corporation created by four companies operating in different branches of the telecommunications industry, the intermediate film system can thus be seen as a result of strategies of industrial consolidation and media convergence.

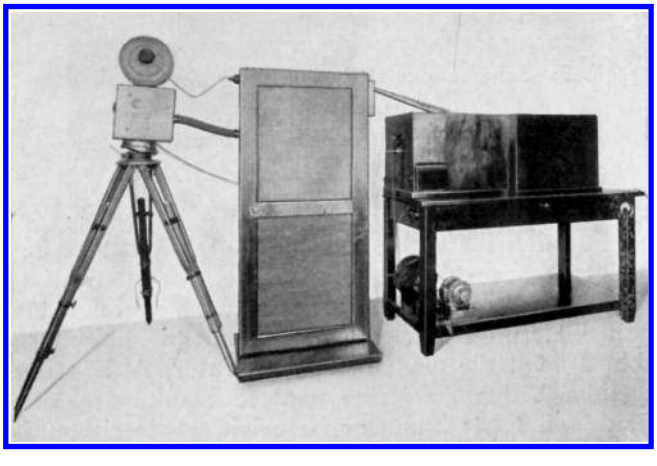
The Intermediate Film System: Making Television with Cinema

The fundamental problem of "seeing at a distance"—that is, the transformation of an optical image into electrical signals for the

instantaneous transmission of audiovisual information—was solved in theoretical terms around 1880. In 1884, Paul Nipkow's patent provided a practical solution that would be widely used from the mid-1920s until the late 1930s. In Nipkow's televisual scheme, the image was decomposed by a rotating disk; a photosensitive cell converted the light into electrical signals. The image, thus reduced in isolated information, was transmitted by wire or wireless to the receiver, which then performed the procedure of decomposing and recomposing in the opposite direction. This mechanical television system would be replaced from the mid-1930s on by fully electronic systems based on cathode ray tube technology.[14]

The intermediate film system, developed in 1930 by Fernseh A.G. and publicly presented for the first time in 1932, was supposed to reduce some of the shortcomings of the first image-transmitting devices through the convergence of televisual and cinematographic technology.[15] In the *Zwischenfilmverfahren*, the image to be transmitted was captured by a cinema camera and recorded on a filmstrip, which was immediately processed by various chemical developing baths before being dried for televisual scanning. Projected on an image scanner (the "tele-cine"), each cinematographic frame was converted into televisual signals and sent via wire or wireless to the television set.[16] The temporal gap between the recording of a scene and its transmission via televisual signals was around 60 seconds on average.[17] The layout of the device, consisting of a "film camera, a film cabinet and the 'tele-cine transmitter' [*Fernkinosender*]," translated the physical proximity of cinematographic components (the reel) and television (the tele-cine) necessary to operate this new technology.[18] From 1933 on, the original layout of the system could be reversed. In this disposition, the televisual signal was intercepted, transferred to film, and projected on a large screen.

The intermediate system was continuously improved; one particular challenge was to reduce the high operating costs caused by the considerable wastage of film reels. Measures taken to lower these costs included the bisection of the filmstrip to 17.5 mm instead of 35 mm, as well as the development of a "continuous" intermediate film system (*kontinuierliches Zwischenfilmverfahren*), in which the developed reel, once scanned, was cleaned and fed again into the structure by a continuous loop. In 1934, Fernseh A.G. built a *Fernsehaufnahmewagen* or truck equipped with the intermediate film system, which allowed for mobile exterior transmissions. Its first use was reserved for the broadcast of the



Below: Film camera, film cabinet, and tele-cine transmitter form the core of the intermediate film system. From *Hausmitteilungen aus Forschung und Betrieb der Fernseh Aktiengesellschaft* (December 1939).

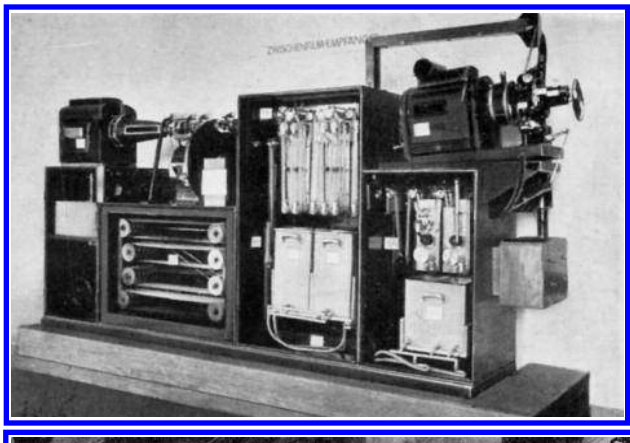
Opposite, top: Continuous intermediate-film-system projector. A strip of film is exposed by a televisual image; the filmstrip is then developed, projected, cleaned, re-sensitized, and exposed again. From *Hausmitteilungen aus Forschung und Betrieb der Fernseh Aktiengesellschaft* (July 1939).

Opposite, bottom: The intermediate film system from recording to projection. From Eduard Rhein, *Van Omroep tot Televisie* (1940), a translation of *Wunder der Wellen: Rundfunk und Fernsehen dargestellt für jedermann* (1935).

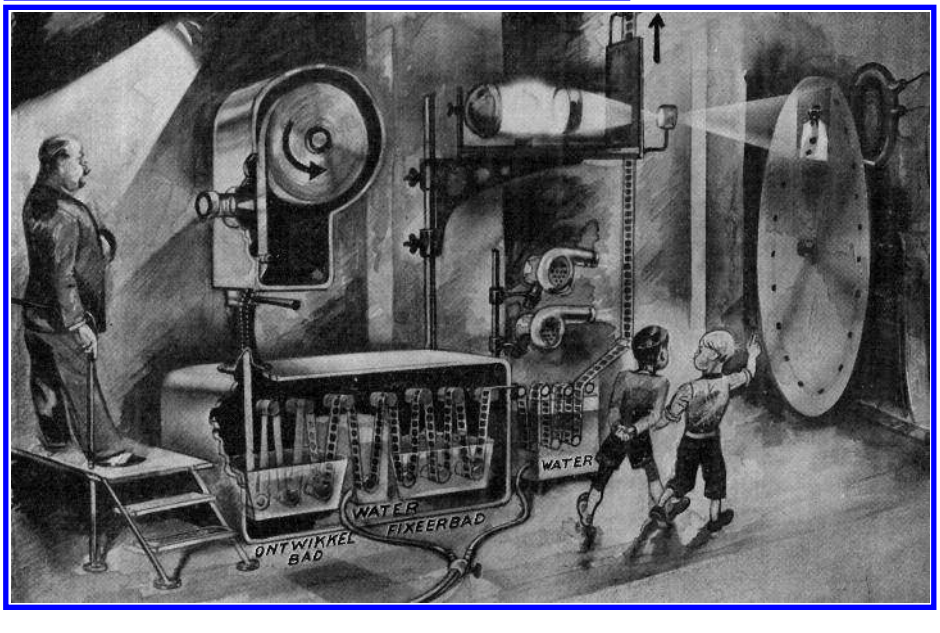
Funkausstellung's opening ceremony, presided over by Joseph Goebbels. His speech was transmitted from the exhibition's stage to the exhibition's "television hall."[19]

After some initial difficulties, the capture and the projection of images could thus be connected: the filmic image, scanned and decomposed in signals, was transmitted televisually, printed again on filmstrip, and projected by a motion picture projector on a large screen. Although a visitor to the 1934 Funkausstellung noted that "to make television with the help of a complete film production facility seems . . . to be a huge detour," he simultaneously expressed his enthusiasm for the device's ingenuity in radically transforming cinema's function:

> This is fantastic. In one, identical operation during the recording and during the broadcast, the film is made solely to be destroyed as soon as it has transferred to the electrical appliances, respectively on the screen, the image that was inscribed on it. The emulsion is immediately washed and the celluloid strip continues to turn empty just to be exposed again after being covered with a new photosensitive layer.[20]



The fusion of film and television at the core of the intermediate film system was translated into the juxtaposition of heterogeneous components and their complex spatial arrangement. As a result, the archival or memorial functions of film were completely removed: instead of perpetuating the luminous trace of an event, the film became an ephemeral medium at the service of a televisual transmission that, in turn, renounced the perfect immediacy that seemed to define it.



Photography, Film, Television: Blurring the Boundaries

The delay introduced between the capture and the broadcast of a televisual image by recording it on film was discussed in the contemporary press, where journalists asserted that this temporal gap "can be accepted without any worries."[21] Another commentator stressed, "the time lag resulting from this intermediate stage [the cinema] is so short that the image in the receiver follows the transmitted scene with an imperceptibly short delay."[22] A third observer expressed admiration for the cinema engineers who had been able to significantly reduce the time necessary to develop a filmstrip: "The entire process . . . does not even last a minute. The film workers have made so much progress."[23] If these evaluations need to be understood within the context of international competition concerning televisual technology in which excessively virulent criticism of national achievements was prohibited, the positive reactions also articulate a conception of television's flexible identity and proximity to other media that was not specific to the intermediate film system.

First, its use as a large-screen projection apparatus reflected ongoing research on collective, extra-domestic televisual consumption, an approach developed internationally from the late 1920s on. In the United States, Ulises A. Sanabria (a key figure in public displays of television technology) exhibited his system at the New York radio show, where a "huge screen" was hung "in the center of the main exhibition floor," transmitting a program broadcast from the basement of Madison Square Garden.[24] A few weeks later, he installed a "ten-foot translucent screen" in a Broadway theater and arranged television demonstrations "during each variety program."[25] Second, the use of filmstrip for television demonstrations was a common practice: film was scanned by a "tele-cine" apparatus and, once transformed into electric information, transmitted to the receivers. In 1932, John V.L. Hogan (director of station W2XR in Long Island City) used "standard 35-mm films of figures, still pictures, rotating figures, various size letters and silhouette cartoons to send a 60-line picture" for its experimental program.[26] Explaining the usefulness of film material for television's future development, he insisted that the lack of immediacy of such programs did not undermine an alleged televisual essence but could offer several advantages over live programming, "if only because it offers the most sensible method of syndicating programs to television stations all over the country."[27] Similarly, the German tests in the early 1930s employed mostly film excerpts chosen from among contemporary silent and sound films and newsreels, insuring that spectators would easily recognize the selections even in the case of mediocre picture quality or very short film excerpts. In discussions touching upon a definition of television, this "recycling" of

film material was not judged to be problematic, because live content was not understood as foundational to the medium's core specificity:

> The general concept of "television" thus includes the transmission of slides, moving pictures, and live transmission of animated or still objects, e.g. individuals or groups of people, street scenes, plays, etc. This transmission is also called immediate or fundamental television [*eigentliches Fernsehen*], while the transmission of moving pictures is called telecinema [*Fernkino*] or, in the case of wireless transmission, broadcast cinema [*Funkkino*].[28]

In writing these lines, Fritz Banneitz (postal minister and future editor of the journal *Fernsehen: Zeitschrift für Technik und Kultur des gesamten elektrischen Fernsehwesens*) did not designate "television" as an independent medium but as a media conglomerate. *Television* was the generic term for at least four different devices. Besides being a distribution system of still slides, it could refer to the transmission of films by wire (*Fernkino*) or wireless (*Funkkino*), as well as to a "fundamental" system providing live broadcasts. The idea of an exclusive medium specificity—crucial to legitimize a "new art," a field of independent research, or a new consumer niche—was absent in Banneitz's conception. With the exception of "fundamental television," all of these devices combined different media practices. The periodical *Daheim* (At home) explained to its readers,

> Since we transmitted acoustic impressions, why should we not succeed in sending optical impressions at a distance? Technology picked up this idea. From the outset it was obvious that two possibilities existed for its realization: either we captured the events without delay at the moment in which they were happening. . . . Or we fixed [them] first on a filmstrip. Then we transmitted the pictures . . . at a distance. By sending the images without delay, we dealt with pure "television" [*reines Fernsehen*]. By recording them first on filmstrip, we created the telecinema [*Fernkino*].[29]

The only difference between "television" and "telecinema," the article continued, followed from the immediacy of perception they offered. Like radio, television provided direct access to an event, "which only lasted as long as it did in reality." The telecinema, compared to gramophone records, allowed the viewer to "screen the events as often as desired." Fundamentally, however, both techniques consisted in nothing more than "beschleunigte Bildtelegrafie"—accelerated phototelegraphy.[30]

The interdependence of television with other media was further reflected in notions such as *Fernkino* and *Funkkino*—

or *Telefotografie*, *Radiokinematografie*, or *Fernfotografie* (terms also employed in the 1920s and 1930s). Associating radio, photography, and cinema with television, these compounds questioned the televisual paradigm of immediacy by their very names. The combination of several media to create a new audiovisual system translated the machines' material hybridity and highlighted their conceptual interchangeability. Television's novelty lay in its capacity for rapid information transmission over distance—whether this information had been previously recorded did not matter.

This conception of television seems at odds with its presumed essence as a live medium, which not only pervades much recent scholarship but also informed the debate over television's specificity in the interwar period. Speculating about the medium's potential in 1935, Rudolf Arnheim described television as a "pure means of transmission" that lacked "the elements of an original artistic elaboration of reality" but "modified our relations with reality itself":

> We see the people gathered together in the central square of a near-by [*sic*] city, we see the head of the government of a neighboring state, we see boxers fighting for the world's title on the other side of the ocean, we see an English jazz band, an Italian soprano, a German professor, the burning members of a train that has collided, the masked figures of carnival. . . . [W]e can admire the sun setting behind Vesuvius and a second later the illuminated night-signs of New York. The need for the descriptive word disappears as the barrier of foreign language vanishes. The world in all its vastness comes to our room.[31]

According to Arnheim, television's space-binding qualities produce a map of nation-states appearing simultaneously on the screen. Abolishing the need for linear textual description or translation, televisual visuality recreated the world in the intimacy of domesticity and generated a new topography where private and public space merged.[32] These properties, presented as fundamental to television, echo the discursive construction of the medium as "window on the world" that emerged with the first televisual utopias from the 1870s on. Privileging the remote visuality associated with the capacity of instantaneous vision, George du Maurier's caricature *Edison's Telephonoscope (Transmits Light as well as Sound)* (1878) and Albert Robida's "téléphonoscope" from his science fiction novel *Le vingtième siècle* (1883) helped to shape the "televisual paradigm" of immediacy, presence, intimacy, simultaneity, and ubiquity. Drawing their inspiration from recent experiences with electrical telegraphy and telephony, these authors described a world of audio-

visual, global communication, which they presented in the popular press, thus disseminating it beyond an expert community. Explicitly linked to the experience of modernity—to the alteration of spatiotemporal relations through new communication and new means of transportation—these fictions nourished representations of and responses to media technologies before their material emergence.[33] Concurrently with these popular imaginations, inventors described first sketches for televisual prototypes in scientific journals and filed first patents for complete systems, fueling hopes for a technical realization of televisual dreams.

Given the apparently univocal identity of the nineteenth century inventions as "purely" televisual communication—that is, simultaneous, immediate, ubiquitous, and audio*visual*—these science fictions seem to reflect television's ontology and specificity. Foregrounding "liveness," they appear to predict the medium's alleged "key aesthetic value" for producers and spectators and to anticipate a "key concept" for television studies.[34] While the idea of television's liveness continues to exert attraction on academic and popular discourse, television scholars have critically discussed the centrality of this notion for the medium's history.[35] Within the context of this study, holding onto the televisual "myth of liveness" would marginalize the medium's multiple forms and practices, in particular those linked to cinema.[36] It would also veil the intertwined histories of multiple media technologies and theories, which echo the intermediate film system's hybrid identity.

In 1891, Raphael Eduard Liesegang published his study *Das Phototel: Beiträge zum Problem des electrischen Fernsehens*, which is often credited for introducing the German word for television, *Fernsehen*.[37] Dedicated to Thomas A. Edison, the text was presented as the first volume of a series addressing the "problems of the present" and tackled theoretical, mechanical, and historical questions related to picture transmission.[38] In his discussion of the differences between picture telegraphy and (hypothetical) televisual systems, which he situated in their respective speeds of transmission, Liesegang argued that television needed to be based on "a number of rapidly successive images, each of which shows the same object in a slightly different location but gives the observer the idea that he could see a continuous movement (based on the same principle as the stroboscopic discs)."[39] Referring to the much-debated theory of the persistence of vision, this description of a rapid succession of consecutive, still images, together with the reference to Simon Ritter von Stampfer's stroboscope, points to two of the conceptual anchors of cinema's "prehistory."[40] As Liesegang was aware, the theory of the persistence of vision, as well as its practical applicability in the form of optical toys, provided a theoretical background for understanding

the televisual flow of images. One of the most fundamental principles for protocinematographic theories thus also informed the same publication that publicized the term *Fernsehen* to German-speaking readers.

Trained as a chemist and a photographer, Liesegang was a prolific writer who acted as main editor for the journal *Photographisches Archiv*. He was also centrally involved in his family company, a well-known manufacturer of projectors, photographic apparatuses, and other optical material. His interest in "electric vision" accompanied and prolonged these other activities, reflecting, as a journalist observed in 1939, his "universality" and "affinity for newly developed fields of research."[41] However, Liesegang's interest in television was perhaps less exceptional than we might now assume. At the turn of the century, German scientists and practitioners working on photography seemed to be at least briefly interested in this new medium. In the 1899 edition of the *Jahrbuch für Photographie und Reproduktionstechnik*, nine pages were dedicated to "Photographische Fernseher.—Telelektroskop [*sic*]."[42] Referring to Constantin Senlecq's televisual apparatus described in 1877 and to Liesegang's publication of 1891, the *Jahrbuch* reproduced a reportedly much-debated article from the *British Journal of Photography* that presented Jan Szczepanik's "telectroscope" and its technical design. Six years later, the editor of the *Jahrbuch*, Josef Maria Eder, published a *Geschichte der Photographie*, in which one short chapter, "Die photo-elektrischen Fernseher," again mentioned Liesegang's 1891 publication.[43]

Although a more extensive study would be required to detail the shared "lineage" of photography and television around 1900, these examples serve to indicate how professional interest in the inscription of luminous traces on plates and filmstrips was hardly opposed to research on the rapid transmission of "electric" images. Photography, picture telegraphy, and television belonged to related fields of scientific and experimental investigations that developed alongside (proto-)cinematic theories and devices, sharing in their broader epistemic conditions.

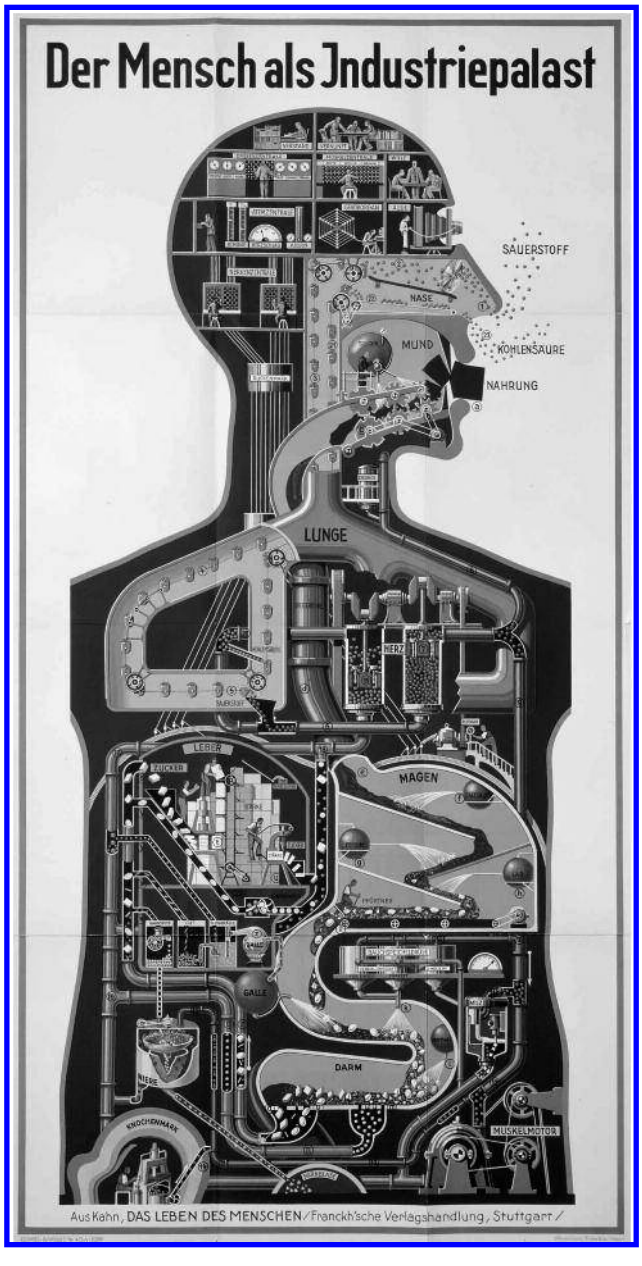
The Intermediate Film System According to Fritz Kahn

Within a different context, Fritz Kahn (1888–1968) thematized the proximity of machines and media paradigms in numerous popular science books published from the 1920s on. Explaining human physiology by blending body parts with modern media technologies, his writings and illustrations allow us to inscribe the intermediate film system's hybridity in a broader media imaginary.

A trained surgeon and obstetrician, Kahn tackled topics related to human anatomy, sexuality, and diseases and accompanied

Fritz Kahn. *Man as Industrial Palace*, 1926.

these (sometimes delicate) issues with abundant illustrations, images that completed the textual explanations by means of a pictorial universe of man-machines.[44] Through the drawings, Kahn promoted a technocratic conception of the body permeated with contemporary debates on socioeconomic modernization, rationalization, scientific management, and technological progress. A combination of industrial machines and scientific artifacts, Kahn's human body was neither an automaton nor a living organism but a hybrid body relying on the efficiency and performativity of its different "anatomical devices." The famous illustration "Man as Industrial Palace" (1926) reflects the skillful use of industrial processes and commodities shaping an imaginary of a fully mechanized human anatomy. Orchestrated by complex devices including telephones and telegraphs, treadmills, refineries and motors, pipes and pumps, this body exposes the interdependence of man and machine, symptomatic of the promises and the contradictions of modernity. Although exceptional in its size and format, the poster also mirrors Kahn's promotional strategies, which embraced the use of luxurious drawings as a distinctive trademark.[45] One of the most popular scientific authors until the 1960s, Kahn hired graphic designers to produce these images, which, consequently, could vary considerably in style within the same publication. Created not by a single author but by a team of anonymous draftsmen, the images therefore reflected in their content the industrial context in which they were created: their mass circulation required rationalized mass production inscribed in the technologized human bodies.[46] More than mere anatomical explanations, Kahn's images produced a self-reflexive discourse that informed their audience as much about the human body as about modern media and production cultures.[47]



In volume four of his successful five-volume work *Das Leben des Menschen* (1922–1931), Kahn imagines a device for the description of the human perceptual apparatus that hinges on a com-

bination of photographic and cinematographic components similar to the intermediate film system (see the frontispiece to my article).[48] Referring to the contemporary mediascape, this ingenious man-machine hybrid describes the sequence of events intervening between the perception of an object and the pronunciation of its name. According to the drawing, the transformation of visual information into spoken word is achieved through a set of processes modeled upon mechanical means of transmission and recording. The object seen by the eye—a key—is impregnated onto the retina, which is "technically speaking . . . a film strip that records events in the outside world thanks to the photosensitive layer through the eyeball's lens and camera."[49] At the moment of the perception of the key, its image is recorded on motion picture film that runs through a complex system of chemical processing (development baths/fixatives and subsequent development of the positive) to be instantly projected on the memorial screen by a minuscule projectionist wearing a white blouse. Here, the photographic print activates the mental image of the key together with the associated linguistic concept. The latter is then projected on a second screen in the forehead and translated into sound by another homunculus playing the vocal cords.

In the center of this representation—and at the basis of the processes of perception and cognition—sits a cinematographic recording and transmitting device describing one of the most instant mechanisms in human physiology. Unless one has to "search for the word" or is affected by a pathology altering the ability to communicate, usually no time lag interferes between the apprehension of an object and its denomination. According to Kahn, the passage from seeing to telling resembles a reflex: "We can hardly see the representation of a key without immediately perceiving the word image [*Wortbild*] before us."[50]

Similar to the spatial arrangement of the various media components in Fernseh A.G.'s device, Kahn's filmstrip runs in loops through the perceptual apparatus. The celluloid does not serve as an archival medium but as an ephemeral vector on which our perception only briefly appears. The memories allowing it to recognize the perceived object are stored outside the cinematographic apparatus, whose function is merely to illuminate the corresponding image and word on the "memory center's" screen.[51] Associated with a continuously renewed stream of images, cinema here becomes a medium of instantaneous information transmission.

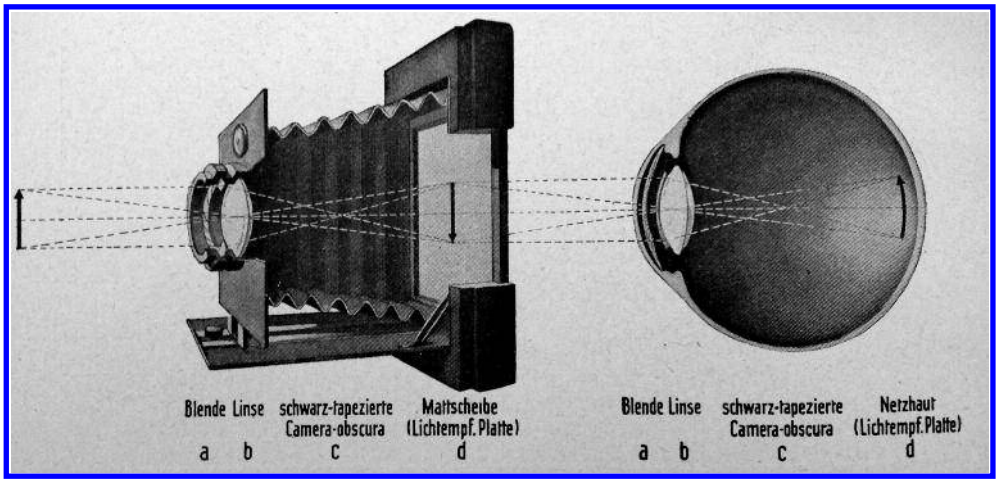
"Picture Reproduction in the Eye, in Printing, and in Television"[52]

Illustrating a nearly perfect model for a technological hybrid, which in turn depicts the human perceptual apparatus, the drawing of Kahn's "intermediate film system" echoed a widespread

idea that "almost all tools, machines, etc. are unconscious copies that imitate parts of the human being," as Raphael Eduard Liesegang writes in the foreword to his *Beiträge zum Problem des electrischen Fernsehens*.[53] Historians of science have acknowledged that such descriptions of media as the "extension of man" are "more than metaphoric," in the sense that they are "revelatory of the processes of signification in science more generally."[54] Or, in Laura Otis's terms, these mechanistic "metaphors do not 'express' scientists' ideas: they *are* the ideas."[55] Prostheses for his own thinking, Kahn's sketches not only mirror the cultural and industrial context in which they were produced, but they stage a reflection on the man-machine analogy. Everywhere the homunculi needed to step in, Kahn pointed to their reductionist character. As Cornelius Borck rhetorically asks, "in the attempt to depict human beings truly as industry plants, the poster visualizes limits of the paradigm—what else do the homunculi indicate?"[56] The portrayal of his man-machines in imaginative pictures allowed—even forced—Kahn to draw the boundaries of such thinking.

When studied comparatively, Kahn's illustrations furthermore reveal the fragility of the information they produced, since the chosen analogies between the technical device and the body varied within one book, as well as from one publication to another. Accordingly, while the photographic camera was recurrently used to illustrate the basic structure of the eye, it did not provide an account of the dynamic sequence of perception, for which Kahn chose the "tele-cinematographic" apparatus. Further, neither of those two media could illustrate the complex design of the retina, which evolved in Kahn's work from a "modern printing process" to a "television apparatus of the human eye." These changing metaphors highlight the historicity of Kahn's knowledge, which depended as much on medical understanding as on technological and industrial progress. What is more, they disrupt essentialist media definitions based on categories such as immediacy and liveness, archiving and storage, and unsettle rigid historical narratives invoking media specificities in favor of more fluid and flexible accounts.

Consisting of millions of photoreceptor cells extending into

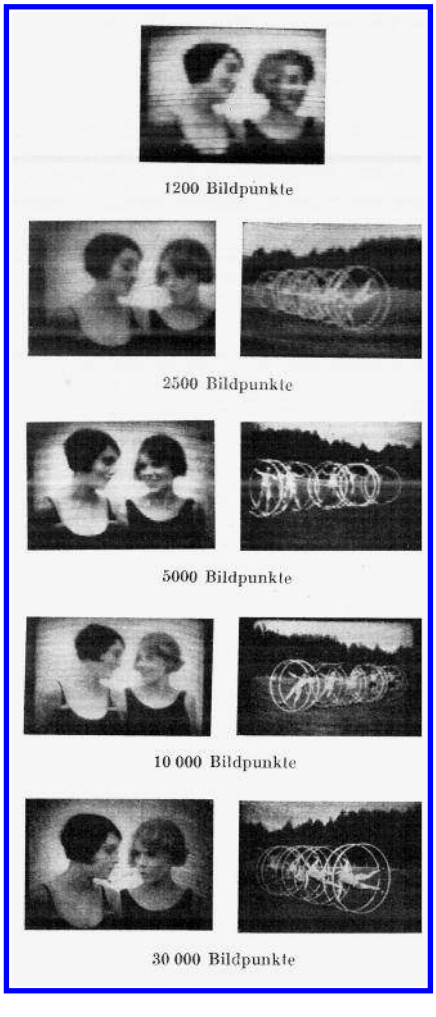


"The visual system in technology and nature." From Fritz Kahn, *Das Leben des Menschen*, vol. 5 (1931).

optic nerves connected to the brain, the retina's anatomical design is not accurately represented by media inscribing luminous traces on one homogeneous surface. As Kahn recognized, "Each photoreceptor . . . can only record one single color impression. With twelve photoreceptors we can receive twelve light signals. . . . In fact, we perceive the world in front of us neither in three nor in two dimensions, but in isolated points."[57] In order to translate this "pointillist" vision into a technical idea, Kahn required another model, similar but not identical to photography and film. In volume five of *Das Leben des Menschen* (1931) he discusses ocular anatomy in detail. Explaining the retina's physical structure, he suggests a comparison with halftone printing: "The eye records its images using the same principle . . . as the modern printing process which composes its image area also by single dots, called the 'grain.'"[58] Like a halftone print, the retinal image is based on independent microscopic components assembling an image in its totality through the combination of its individual elements.

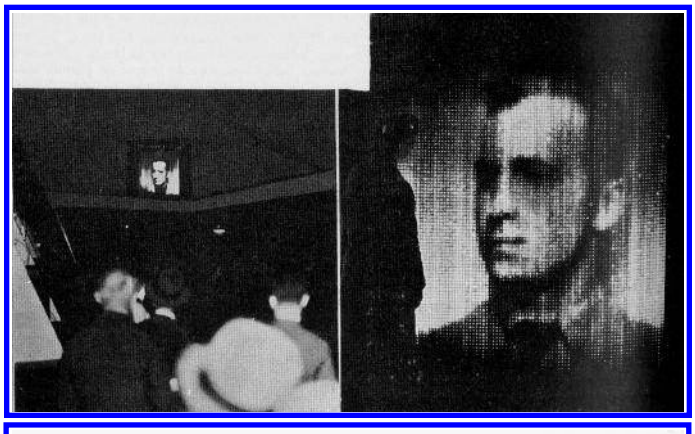
Eight years later, Kahn updated this analogy for the publication *Man in Structure and Function* (1939/1943), where he compares the retina to modern printing methods *and* a televisual system: "for the reception of an image the eye uses the same method as is employed in printing and in television—namely the breaking up of the image into discrete points."[59] Consequently, the retina is henceforth described as "the television apparatus of the human eye, which like that of a broadcasting station transforms optical images into electrical currents."[60] Returning to his "picture point" theory, Kahn again stages the retina and printing comparison but integrates this time contemporary knowledge about television that, by then, had been debated and researched for several decades.

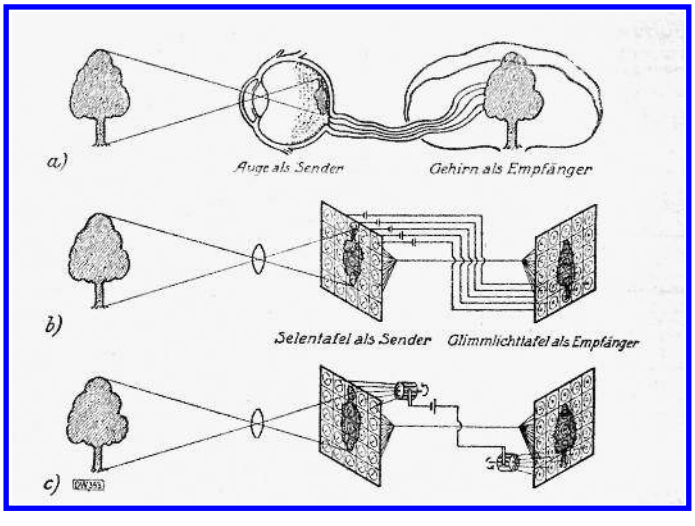
When used for the first time by Kahn, the analogy between television and the retina was already well known. The optical principle of "single dots" at the base of the televisual picture decomposed and recomposed using an ultrafine grid was described in the earliest sketches, where it was immediately compared to the human eye.[61] In a letter to *English Mechanic and World of Science* in 1879, Denis D. Redmond advertised his work on "transmitting a luminous image by electricity" by referring to the retinal model: "By using a number of circuits, each containing selenium and platinum arranged at each end, just as the rods and cones are in the retina, the selenium end being exposed in a camera, I have succeeded in transmitting built-up images of very simple luminous objects."[62] Redmond's proposal conceived a



"mosaic" system in which each photoconductive selenium cell in the camera was connected via wire to an individual receiving cell of a corresponding receiving mosaic.[63] Similar to the retina, the device would thus transmit the image by isolating single elements. These theories of televisual picture elements, Doron Galili argues, would not have been possible without the "discovery of the structure of the retina and the nerve cells" by physicians and scientists earlier in the nineteenth century, research that "played a crucial role in the design of the first models of televisual technology."[64] Furthermore, as Liesegang had already described, the impression of movement produced by the televisual image relied on another physiological theory, the so-called persistence of vision, the optical illusion created by "a series of rapid successive images, each of which shows the same object in a slightly different position [giving] the observer the impression that he sees a continuous movement."[65] While individual components—the images' "grain"—formed the (hidden) structure of apparently stable images, their *mise en movement* was produced by a disjunction between subject and object through which the observer continued to see no longer existing images.[66] In a sense, television thus translated doubly the "generalized crisis in perception" described by Jonathan Crary.[67] Through its fragmented, retinal structure *and* its reliance on duration, the medium highlighted the difficulty of conceiving vision as unmediated or direct, as an "exterior image of the true or the right," and revealed the subjectivity of seeing, produced not outside but within the perceiving subject.[68]

In the 1920s and 1930s, the mosaic structure of televisual images was still intensely debated in Germany, since it proved decisive for picture quality and thus for the potential commercialization of the new technology.[69] The Funkausstellung in 1931 included a demonstration displaying "the dependency of image quality on the number of picture points [*Bildpunktzahl*]."[70] To this end, five small cinema screens were embedded in a panel on which two short films mounted in loops were projected. The two movies, imitating the televisual image, were recorded with 1,200, 2,500, 5,000,





Opposite: Demonstration of the dependency of image quality on the number of picture points at the Berlin radio fair in 1931. From *Fernsehen* (October 1931).

Top: Large-screen television composed of ten thousand lamps exhibited at the 1935 Berlin radio fair. From *Intercine* (November 1935).

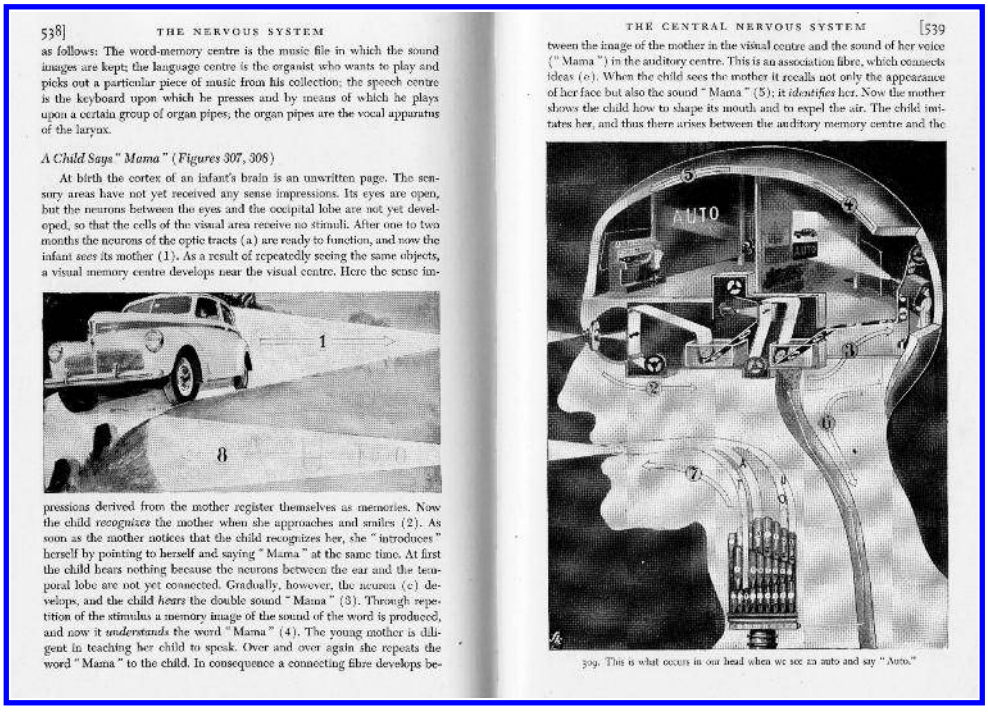
Bottom: "The process of seeing and its imitation by television: *a* = natural sight; *b* = transmission through the multiconductor system; *c* = transmission through the single wire system." Illustration from a 1937 exhibition at the Deutsches Museum, Munich, reproduced in *Radio, Bildfunk, Fernsehen für Alle* (1937).

10,000, and 30,000 picture points respectively in order to account for the qualitative differences between low- and high-resolution images. In addition, although largely superseded by the Nipkow disk and other mechanical components for image scanning, television receivers designed according to the mosaic principle did persist. At the 1935 Funkausstellung, Telefunken presented a large screen receiver composed of 10,000 incandescent lamps spilt into "100 lines each divided into 100 cells and each cell containing one lamp."[71]

The link between perception and televisual devices was drawn for the temporary television exhibition at the Deutsches Museum in Munich in 1937. Held simultaneously with television shows at the Paris Exposition Internationale des Arts et Techniques de la Vie Moderne and a television exhibition at the Science Museum in London, the Munich exhibition contained demonstrations of contemporary devices as well as a historical and an educational section explaining the history of television in relation to the human eye.[72] In an article by one of the museum's curators, the display was described as an illustration for the way in which "the first television inventors have theorized the decomposition of the image for electrical transmissions by studying the point after point transmission of the retinal image from the eye to the brain."[73] The picture accompanying the text highlighted the similarity *and* complexity of television and perception. The televisual "eye" used photoelectric selenium cells instead of the retina, and the optical nerves became multiple or, in more advanced televisual systems, one unique conductor linking transmitter and receiver. The object seen—translated into signals sent via nerves or wires to the receiving apparatus—ceased to exist in its original, exterior form and became a representation

Below: Fritz Kahn's 1943 version of the intermediate film system. "This is what occurs in our head when we see an auto and say 'Auto.'" From Fritz Kahn, *Man in Structure and Function* (1943).

Opposite: "At night when we dream with closed eyes, we certainly don't see anything. The path a–c is as inactive as a television set that is not in use." From Fritz Kahn, *Man in Structure and Function* (1943).



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as follows: The word-memory centre is the music file in which the sound images are kept; the language centre is the organist who wants to play and picks out a particular piece of music from his collection; the speech centre is the keyboard upon which he presses and by means of which he plays upon a certain group of organ pipes, the organ pipes are the vocal apparatus of the larynx.

A Child Says "Mama" (*Figures 307, 308*)

At birth the cortex of an infant's brain is an unwritten page. The sensory areas have not yet received any sense impressions. Its eyes are open, but the neurons between the eyes and the occipital lobe are not yet developed, so that the cells of the visual area receive no stimuli. After one to two months the neurons of the optic tracts (a) are ready to function, and now the infant sees its mother (1). As a result of repeatedly seeing the same objects, a visual memory centre develops near the visual centre. Here the sense impressions derived from the mother register themselves as memories. Now the child *recognizes* the mother when she approaches and smiles (2). As soon as the mother notices that the child recognizes her, she "introduces" herself by pointing to herself and saying "Mama" at the same time. At first the child hears nothing because the neurons between the ear and the temporal lobe are not yet connected. Gradually, however, the neuron (c) develops, and the child *hears* the double sound "Mama" (3). Through repetition of the stimulus a memory image of the sound of the word is produced, and now it *understands* the word "Mama" (4). The young mother is diligent in teaching her child to speak. Over and over again she repeats the word "Mama" to the child. In consequence a connecting fibre develops be-

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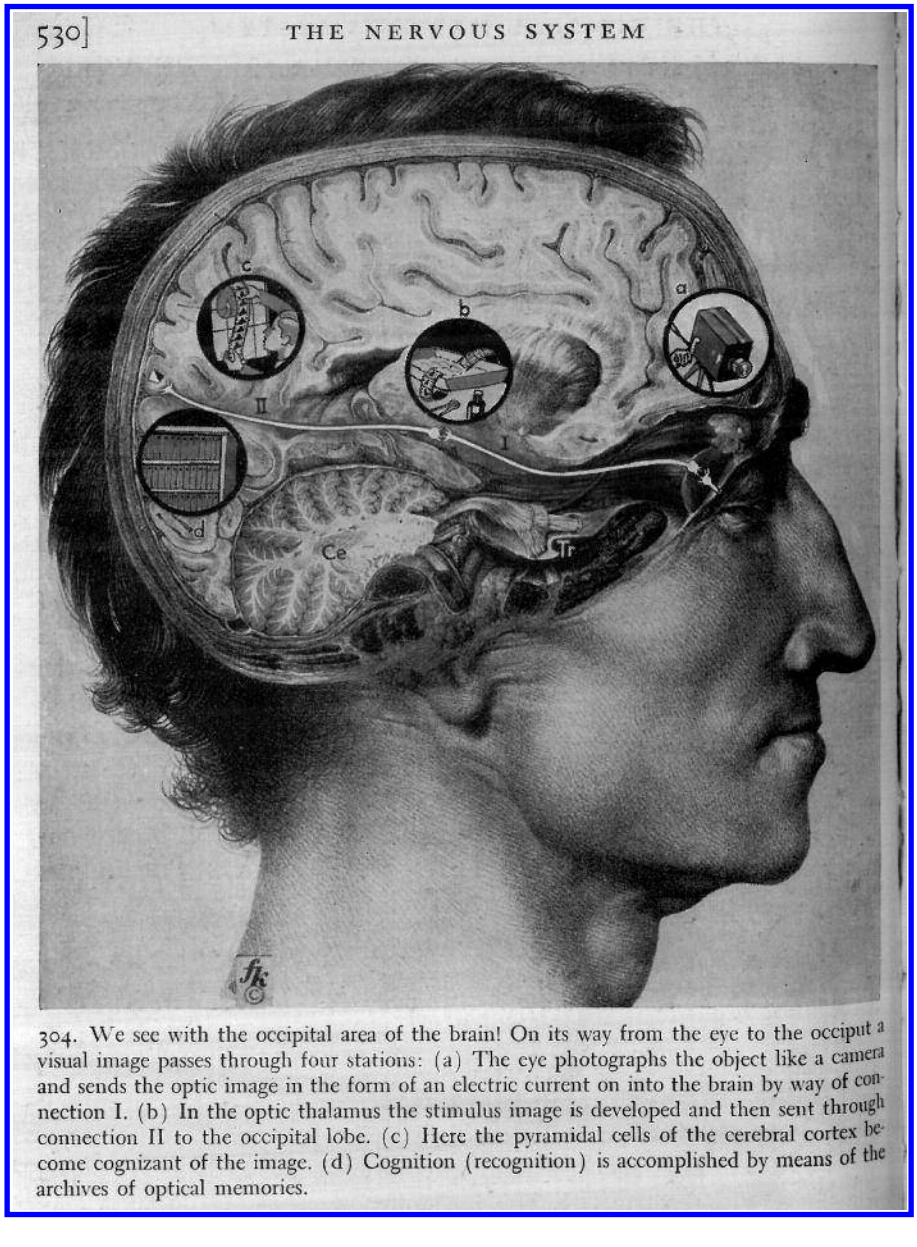
tween the image of the mother in the visual centre and the sound of her voice ("Mama") in the auditory centre. This is an association fibre, which connects ideas (e). When the child sees the mother it recalls not only the appearance of her face but also the sound "Mama" (3); it *identifies* her. Now the mother shows the child how to shape its mouth and to expel the air. The child imitates her, and thus there arises between the auditory memory centre and the

309. This is what occurs in our head when we see an auto and say "Auto."

mediated by the human or the technological apparatus.

When Kahn described the "television apparatus of the human eye," he echoed these debates about picture points and the "televisual eye," while further complicating the comparison between human systems and machines. The mosaic scheme was first used in Kahn's work to draw an analogy between the retina and halftone printing. In the 1943 publication, it referred to printing *and* television and thus pointed to the contiguity of supposedly distinct media. However, the use of television for anatomical descriptions did not result in a suppression of the "telecinematographic" apparatus depicted in 1929. Instead, the publication included a new version of Kahn's "intermediate film system." Aside from minor changes, it is identical to the earlier illustration.[74] Again we see a complex arrangement of filmstrips,



chemical developer baths, and homunculi ordered so as to make intelligible invisible cognitive activities.

Finally, in another drawing from the same book, the cinematographic and the televisual model definitively converge. In this picture, the perceived images are printed onto film strips developed on their way between the eye and the "occipital area of the brain" *and* simultaneously sent "in the form of an electric current" toward "the *pyramidal cells* of the cerebral cortex."[75] Cinema (represented in inserts forming "path a–c") and television (figured by the electrical cable) *were* identical: "At night when we dream with closed eyes, we certainly don't see anything. The path a–c is as inactive as a television set that is not in use."[76] For Kahn, cinema and television did not represent opposed media technologies with exclusive characteristics. On the contrary, complementing each other, they became interchangeable. Similar to the retinal mosaic scheme compared to half-tone print and television, this new perceptual apparatus with its cameras, projectors, *and* TVs highlighted the affinities between different media technologies. Blurring notions of liveness and storage, immediacy and archive, Kahn's multifaceted media imaginary echoed the actual intermediate film system's "impurity" and its open definition resisting an unambiguous categorization as "television" or "cinema." Within another context, his work thus raises questions similar to those raised by Fernseh A.G.'s machine and invites us to historicize our contemporary convergence culture and its shifting media boundaries.

Industrial Consolidation and Technological Hybridity

To this point, I have discussed the intermediate film system's hybridity mainly from a media archeological perspective, highlighting the multiple circulations among technologies and scientific, medical, and cultural discourses. In this last section, I suggest a different approach by taking into account the industrial and economic context of this televisual device. The intermediate film system's heterogeneous materiality (combining film and television technologies) can also be understood as a direct consequence of the "first wave of media convergence" in the 1920s and 1930s.[77] In particular, the emergence of sound film further bound the radio, music, and film industries and created a "convergence culture" that reflected the absorption of mass media within a transnational, corporate-led economy.[78] Innovation, boosted in corporate research laboratories, represented a central factor in the stabilization and growth of economic power through the securing of additional fields of activity and the registration of new patents.[79] As televisual research became an important branch of industrial scientific activity during the 1930s, it appeared that this new technology would open fields for new investment and doors to new

profits for telecommunication corporations, whether as part of the entertainment industry or the military-industrial complex.[80]

Fernseh A.G., the main developer of the intermediate film system, provides an exemplary case for the study of television as a product of industrial convergence and media consolidation. Founded in 1929, the firm emerged from a collaboration between one British and three German companies active in various branches of electrical engineering and mass media. Robert Bosch G.m.b.H. (Stuttgart) produced electric motors and measurement tools. Zeiss Ikon A.G. (Dresden) was a specialist in optical and photographic equipment, including movie projectors. Loewe Radio G.m.b.H. (Berlin) was among Germany's leading radio manufacturers. Baird Television Ltd. (London) was one of the major players in the development of television internationally.[81] At the formation of the Fernseh A.G., only Baird Television Ltd. had experience in televisual research. Its collaboration with German industry was part of the firm's desire for international expansion, all the more necessary since the British Broadcasting Corporation (BBC) was reluctant to offer support for Baird's projects. Loewe Radio had begun its research on television shortly before the creation of Fernseh A.G. as part of its continuous research efforts on wireless communication. The subsequent participation in a joint venture allowed it to share the expenses of this research and to take advantage of additional expertise.[82] For Bosch G.m.b.H., the commitment to television translated the firm's outlook for diversification strategies highlighted in its activity report of 1931: "The reduction . . . of business opportunities has forced us to methodically seek to expand the scope of our production."[83] As a reaction to the economic crisis, the company started the production of new commodities, such as "batteries for motor cars and commercial vehicles, steering wheels for cars, fog lamps," while also acquiring radio manufacturers and expanding its involvement in televisual research.[84] Recently established after a merger of photographic and cinema companies, Zeiss Ikon had reacted slowly to the introduction of sound film and sought to place itself at the forefront of the newest telecommunication technology.[85] Fernseh A.G.'s stated purpose consisted of "the acquisition and exploitation of patents in the field of television, as well as the production and distribution of television devices of all kind" and thus embraced any televisual idea or machine that could potentially stimulate the company's research efforts and revenues.[86] By the end of the 1930s, this also involved working on several televisual devices for military uses, such as the development of a remote-controlled bomb and a system for aerial reconnaissance.[87] Resonating here with Friedrich Kittler's more theoretical than historical media genealogy that describes television as a "fallout" of radar technologies and

"VHF tank communications" and largely "a civilian byproduct of military electronics," Fernseh A.G.'s history reflects in an exemplary way the flexibility and adaptability of the telecommunications industry.[88]

The intermediate film system's own hybridity can be understood as a result of this flexible use of capital, human resources, and technological savoir-faire constituting the heart of the corporation. Uniting four powerful actors with highly specialized knowledge, Fernseh A.G. essentially ran "multimedia" operations from which the "tele-cinematographic" apparatus emerged. The convergence of cinematographic material and television equipment fundamental to the system corresponded to the business partners' different competences and their various fields of excellence. The "impurity" of the device materialized the industrial and economic convergence at Fernseh A.G.'s core, the machine's technological and conceptual hybridity ultimately reflecting the manufacturer's heterogeneous constitution. From this perspective, the intermediate film system mirrored the logic of modern capitalism, its "economics of innovation," and the growing concentration of media ownership.[89]

Rather than constituting a historical anomaly, the intermediate film system illustrates how historical writing tends to marginalize technological objects and their narratives that do not resolve into canonical categories of standardized, institutionalized, normalized devices, actors, or ideas. Its study confirms that commonplace definitions of television—as domestic, live, ubiquitous—are "conceptual filter[s]" that ignore other "discursive registers," technological inventions, and spectatorial practices that developed simultaneously to the canonized televisual apparatus.[90] Historians of television attentive to alternative historiographies have revised the common definition of a domestic live medium and argued that television's essence—if there is such—would be its "constant transformation" as a technology and a cultural form.[91] Their research shows that television's "highly instable" identity in the age of digitization and media convergence merely reflects its fundamental and historically uninterrupted adaptability.[92] The intermediate film system offers a particularly telling example for television's technological and conceptual hybridity that prompts not only a revisiting of television's early years but, more fundamentally, questions common distinctions between multiple media and their histories.

The analysis of discourses, practices, and technologies of the intermediate film system highlights the complexity and diversity of factors that determine its open and flexible definition. The bifurcation of television and cinema based on their respective speed of transmission and storage capacity is blurred, and the categories of recording and transmission, archiving and immedi-

acy, are recombined until a univocal classification of media technologies is hardly possible. Instead of a specific history of cinema, of television, of photography, and of radio, the intermediate film system calls for a narrative encompassing composite and heterogeneous media forms that emerge at the intersections of henceforth inseparable paradigms and industries. In lieu of independent media qualified by a stable identity, hybrid machines appear, situated not so much *inter*- two media but at the exact location where the two converge.

Notes

I thank Olivier Lugon for his support and assistance during the research and writing of this text, and the editors of *Grey Room* for their valuable comments and corrections. All translations are by the author unless otherwise noted.

1. "Die Schau der neuen Möglichkeiten: Vergangenheit, Gegenwart und Zukunft an der Funk-Ausstellung," *Berliner Zeitung am Mittag,* 1 September 1928.

2. Albert Neub[u]rger, "The Karolus System of Television," *Television: the World's First Television Journal* 1, no. 8 (1928): 35. The British journal misspells the author's name, writing *Neuberger* instead of *Neuburger.* The former was to become a famous medical researcher; Neuburger was a scientific writer and editor, among others, of the *Elektrochemische Zeitschrift.* In addition to Telefunken's television demonstration, Dénes von Mihály, a Hungarian inventor backed by the German Reichspost, presented a receiver called "Telehor."

3. W. Jilberg, "Ein Jahrzehnt Bildtelegrafie und Fernsehen Telefunken—Karolus," *Telefunken-Zeitung* 14, no. 65 (November 1933): 19.

4. Neub[u]rger, "The Karolus System," 35.

5. Fritz Schröter, "Versuche zur optischen Ergänzung des Rundfunks," *Telefunken-Zeitung* 8, no. 45–46 (1927): 41.

6. "Was bringt die Deutsche Funkausstellung 1928?" *Radio-Bern* 5, no. 35 (1928): 565.

7. The 1928 edition of the annual Berlin radio show included for the first time a projection of a sound film; namely, Walter Ruttmann's lost *Tönende Welle.* See Walter Ruttmann, "Prinzipielles zum Tonfilm," *Film und Volk* 2, no. 2 (December/January 1927/1928): 2.

8. Graeme Gooday, "Re-writing the 'Book of Blots': Critical Reflections on Histories of Technological 'Failure,'" *History and Technology* 14 (1998): 270.

9. Erkki Huhtamo and Jussi Parikka, "Introduction: An Archeology of Media Archeology," in *Media Archaeology: Approaches, Applications, and Implications*, ed. Erkki Huhtamo and Jussi Parikka (Berkeley and Los Angeles: University of California Press, 2011), 1–21. On the importance of "anticipations" for media history, see François Albera, "Projected Cinema (A Hypothesis on the Cinema's Imagination)," in *Cinema beyond Film: Media Epistemology in the Modern Era,* ed. François Albera and Maria Tortajada (Amsterdam: Amsterdam University Press, 2010), 45–58.

10. Simone Natale, "Understanding Media Archeology," *Canadian Journal of Communication* 37 (2012): 526; and Siegfried Zielinski, *Deep Time of the Media: Toward an Archaeology of Hearing and Seeing by Technical Means* (Cambridge, MA: MIT Press, 2006), 3.

11. In contemporary English sources, the translation varies and includes, for instance, "delayed television" (Joseph McCabe, *Television—What It Is and How It Works* [Girard, KS: Haldeman-Julius Publications, 1937], 17) or "intermediate film process" (Stanley Kempner, *Television Encyclopedia* [New York: Fairchild Pub. Co., 1948], 28), while the term "intermediate film system" is also in use ("Television Progress in Germany," *Wireless World* 37 [July 1935]: 29).

12. In Germany, Fernseh A.G. was the most important, but not the only, corporation working on the intermediate film system: Telefunken also investigated the possibilities of this tele-cinematographic device.

13. Huhtamo and Parikka, "Introduction," 3.

14. Commonly used in television historiography, the opposition "mechanical vs. electronic" television is problematic insofar as electricity played a fundamental role in early devices. For a detailed introduction to the technological

history of "early" television, see Russell W. Burns, *Television: An International History of the Formative Years* (London: IEEE, 2007).

15. G. Schubert, W. Dillenburger, and H. Zschau, "Das Zwischenfilmverfahren: III. Teil," *Hausmitteilungen aus Forschung und Betrieb der Fernseh G.m.b.H., Berlin* 1, no. 6 (December 1939): 201.

16. The scanning of filmstrips for their televisual transmission has been called *tele-cinema*, *tele-cinematography*, and *telecine*. The spelling *tele-cine* seems to be the most common, however. See Bernard R. Regen and Richard R. Regen, *German-English Dictionary for Electronics Engineers and Physicists with a Patent-Practice Vocabulary* (Ann Arbor: J.W. Edwards, 1946).

17. According to contemporary sources, the delay between the recording and the transmission of the televisual image was between fifteen and ninety seconds.

18. Georg Kette, "Das Fernsehen auf der Berliner Funkausstellung 1932," *Fernsehen und Tonfilm: Zeitschrift für Technik und Kultur des Fernsehwesens und des Tonfilms* 3, no. 4 (1932): 198.

19. Georg Kette, "Funkausstellungs-Bericht," *Fernsehen und Tonfilm: Zeitschrift für Technik und Kultur des Fernsehwesens und des Tonfilms* 5, no. 5 (1934): 60.

20. Willy Steckmann, "Fernseh-Kino," *Reichsfilmblatt* 13, no. 35 (1934): n.p.

21. Kette, "Das Fernsehen," 198.

22. Fritz Banneitz, "Fernsehen," in *Offizieller Katalog der Funk-Ausstellung Berlin 1933* (Berlin: Messe- und Fremdenverkehrs G.m.b.H, 1933), 39–40.

23. Eduard Rhein, *Wunder der Wellen. Rundfunk und Fernsehen dargestellt für jedermann* (Berlin: Ullstein, 1937 [1935]), 262.

24. "Radio World's Fair Opens," *New York Sun*, 21 September 1931.

25. "Television to Link Theatres in Test," *New York Times*, 14 October 1931. The description of this demonstration in the *New York Times* is intriguing: "the entire television apparatus, including sending and receiving equipment, will be in operation during each variety program at the Moss theatre. The television transmitting booth will be wheeled out on the stage. Suspended above the stage will be the ten-foot translucent screen on which the images will be shown. Thus, the actors will be seen by the audience both as microphone and television eye pick-up their voices and images, and as they appear on the television screen suspended above."

26. Joseph H. Udelson, *The Great Television Race: A History of the American Television Industry, 1925–1941* (Tuscaloosa: University of Alabama Press, 1982), 63.

27. John V.L. Hogan, "Films Best for Television," *New York Sun*, 23 September 1932.

28. Fritz Banneitz, "Der heutige Stand des elektrischen Fernsehens," in *Funkalmanach 1929: Grosse Deutsche Funkausstellung 1929* (Berlin: Rothgiesser und Diesing, 1929), 53.

29. Ernst Steffen, "Das Fernkino im Haus" (1929), in *Medientheorie 1888–1933: Texte und Kommentare*, ed. Albert Kümmel and Petra Löffler (Frankfurt: Suhrkamp, 2002), 433–434.

30. Steffen, "Das Fernkino im Haus," 433–434.

31. Rudolph [*sic*] Arnheim, "Seeing Afar Off," *Intercine* 7, no. 2 (February 1935): 77.

32. Arnheim's writings have recently received renewed attention from media scholars seeking to discuss his media theory beyond the classical *Film as Art*. In regard to television, Doron Galili argues that Arnheim's thinking was very much influenced by intermedia relations, since his method is based on a comparative study of television, cinema, and radio that highlights similarities *and* differences between these forms. While the common perception of Arnheim as a media "essentialist" should thus be nuanced, his speculative texts on televi-

sion translate a normative approach defining the medium's core specificities. Doron Galili, "Television from Afar: Arnheim's Understanding of Media," in *Arnheim for Film and Media Studies,* ed. Scott Higgins (New York: Routledge, 2010), 195–211.

33. Stephen Kern, *The Culture of Time and Space, 1880–1918* (Cambridge, MA: Harvard University Press, 1983). On Albert Robida, see Alain Boillat, "L'imaginaire social de la téléphonie: Les dispositifs fictifs du XXe siècle d'Albert Robida et l'archéologie du cinéma parlant," in *Ciné-dispositifs: Spectacles, cinéma, télévision, littérature*, ed. François Albera and Maria Tortajada (Lausanne: L'Âge d'Homme, 2011), 229–259.

34. Jostein Gripsrud, "Television, Broadcasting, Flow: Key Metaphors in TV Theory," in *The Television Studies Book*, ed. Christine Geraghty and David Lusted (London: St. Martin's Press, 1998), 19; and Mimi White, "The Attractions of Television: Reconsidering Liveness," in *Media Space: Place, Scale, and Culture in a Media Age,* ed. Nick Couldry and Anna McCarthy (New York: Routledge, 2004), 76.

35. See Gripsrud, "Television"; White, "The Attractions of Television"; and John Thornton Caldwell, *Televisuality: Style, Crisis, and Authority in American Television* (New Brunswick, NJ: Rutgers University Press, 1995), 27–31.

36. Caldwell, *Televisuality*, 28.

37. Raphael Eduard Liesegang, *Das Phototel: Beiträge zum Problem des electrischen Fernsehens* (Düsseldorf: Liesegang Verlag, 1891). The story is imprecise: while Liesegang might have been the first to use *Fernsehen* to describe the particular media device, the word was used decades earlier in optics and in occultist literature. See, for instance, *Ueber Augen, Augenübel, Kurzsichtig- und Weitsichtigkeit, Brillen und Ferngläser; Oder, kurze Anweisung, ein Gutes Gesicht zu Erhalten: Aus den Schriften bewährter Augenärzte und Optiker gezogen . . .* (Eichstädt, Germany: Beyer, 1824); and Heinrich Werner, *Die Schutzgeister, oder, merkwürdige Blicke zweier Seherinnen in die Geisterwelt: Nebst der wunderbaren Heilung einer zehn Jahre stumm Gewesenen durch die Lebensmagnetismus, und einer Vergleichenden Uebersicht aller bis jetzt beobachteten Erscheinungen desselben* (Stuttgart: Druck und Verlag der Cotta'schen Buchhandlung, 1839). On the alleged first use of the term, see Siegfried Zielinski, *Audiovisions: Cinema and Television as Entr'actes in History* (Amsterdam: Amsterdam University Press, 1999), 32.

38. Only two volumes of this series were published, the second being Raphael E. Liesegang, *Der Monismus und seine Konsequenzen* (Düsseldorf: Liesegang Verlag, 1892).

39. Liesegang, *Das Phototel*, 93–94.

40. Simultaneously with Joseph Plateau, who developed the phenakistiscope, von Stampfer invented the stroboscope. Both "optical toys" were based on retinal persistence. On the persistence of vision and its role in nineteenth-century theories of perception, see Jonathan Crary, *Techniques of the Observer* (Cambridge, MA: MIT Press, 1992), 107–116.

41. Erwin Miehlnickel, "'Electrisches Fernsehen'—vor fünfzig Jahren," *Kolloid-Zeitschrift* 89, no. 2 (1939): 128.

42. Josef Maria Eder, *Jahrbuch für Photographie und Reproduktionstechnik für das Jahr 1899* (Halle: Wilhelm Knapp, 1899), 440–448.

43. Josef Maria Eder, *Geschichte der Photographie: Ausführliches Handbuch der Photographie* (Halle: W. Knapp, 1905), 313–314.

44. Surprisingly little scholarly literature exists on Kahn's work. The recent publication by Taschen on the occasion of Kahn's 125th birthday of a 400-page volume with over 300 illustrations will change this situation. See Cornelius

Borck, "Communicating the Modern Body: Fritz Kahn's Popular Images of Human Physiology as an Industrialized World," *Canadian Journal of Communication* 32 (2007): 495–520; and Uta von Debschitz, Thilo von Debschitz, and Steven Heller, eds., *Fritz Kahn* (Cologne: Taschen, 2013).

45. Borck, "Communicating the Modern Body," 503–506.

46. As Cornelius Borck observes, the American editions of Kahn's books streamlined "most of the original and originally contradictory heterogeneity in visualization into a coherent style" and definitively commodified the illustrations through the addition of the stamp "©FK" regulating copyrights and commercial authorship. The publication by Taschen, which isolates the drawings from their context and presents them in a unified manner as independent artifacts, continues this commodification started by Kahn. Borck, "Communicating the Modern Body," 507; and Debschitz, Debschitz, and Heller, *Kahn*.

47. I will continue to refer to Kahn as the author of the images, despite the collaborative origins of these artifacts.

48. Fritz Kahn, *Das Leben des Menschen: Eine volkstümliche Anatomie, Biologie, Physiologie und Entwicklungsgeschichte des Menschen*, vol. 4 (Stuttgart: Kosmos Gesellschaft der Naturfreunde, 1929).

49. Kahn, *Das Leben des Menschen*, vol. 4, 80.

50. Kahn, *Das Leben des Menschen*, vol. 4, 81.

51. The screen on which the image of the key appears is described as "Erinnerungszentrum."

52. Fritz Kahn, *Man in Structure and Function,* vol. 2, trans. and ed. George Rosen (New York: A.A. Knopf, 1943), 659.

53. Liesegang, *Das Phototel*, iii.

54. Timothy Lenoir, "Inscription Practices and Materialities of Communication," in *Inscribing Science: Scientific Texts and the Materiality of Communication*, ed. Timothy Lenoir (Stanford, CA: Stanford University Press, 1998), 1.

55. Laura Otis, "The Metaphoric Circuit: Organic and Technological Communication in the Nineteenth Century," *Journal of the History of Ideas* 63, no. 1 (2002): 127.

56. Borck, "Communicating the Modern Body," 515.

57. Fritz Kahn, *Das Leben des Menschen: Eine volkstümliche Anatomie, Biologie, Physiologie und Entwicklungsgeschichte des Menschen*, vol. 5 (Stuttgart: Kosmos Gesellschaft der Naturfreunde, 1931), 50.

58. Kahn, *Das Leben des Menschen*, vol. 5, 50.

59. Fritz Kahn, *Man in Structure and Function*, 659. Originally published as *Der Mensch Gesund und Krank* (Zurich: Albert Müller Verlag, 1939).

60. Kahn, *Man in Structure and Function*, 662.

61. Doron Galili, "L'histoire des débuts de la télévision et les théories modernes de la vision," in *Télévision: Le moment expérimental: De l'invention à l'institution (1935–1955*), ed. Gilles Delavaud and Denis Maréchal (Rennes: Éditions Apogée, 2011), 141–144. See also Burns, *Television*, 41–62.

62. Denis D. Redmond, "An Electrical Telescope," *English Mechanic and World of Science* 28, no. 724 (February 1879): 540.

63. The comparison between the televisual image and a "mosaic" is made by Paul Nipkow in a text published shortly after he obtained the patent for his "Elektrisches Teleskop." Paul Nipkow, "Der Telephotograph und das elektrische Teleskop," *Elektrotechnische Zeitschrift* 6 (October 1885): 419.

64. Galili, "L'histoire des débuts," 144.

65. Paul Nipkow, "Der Telephotograph," 421.

66. Crary, *Techniques,* 104.

67. Jonathan Crary, *Suspensions of Perception: Attention, Spectacle, and Modern Culture* (Cambridge, MA: MIT Press, 1999), 2.

68. Crary, *Techniques*, 138.

69. Birgit Schneider, "Die Kunstseidenen Mädchen: Test- und Leitbilder des frühen Fernsehens," in *1929: Beiträge zur Archäologie der Medien*, ed. Stefan Andriopoulos and Bernhard Dotzler (Frankfurt: Suhrkamp 2002), 54–79.

70. Georg Kette, "Die Fernsehschau auf der Berliner Funkausstellung 1931," *Fernsehen: Zeitschrift für Technik und Kultur des gesamten elektrischen Fernsehwesens* 2, no. 4 (1931): 226.

71. E.H. Traub, "Television at the Berlin Exhibition," *Journal of the Television Society* 2 (December 1935): 56.

72. Kilian Steiner, "Die Sonderschau 'Fernsehen' im Deutschen Museum," in *Das Deutsche Museum in der Zeit des Nationalsozialismus: Eine Bestandsaufnahme*, ed. Dorothee Messerschmid-Franzen and Elisabeth Vaupel (Göttingen: Wallstein Verlag, 2010), 581–616. On the Paris and London exhibitions, see Andreas Fickers, "Presenting the 'Window on the World,' to the World: Competing Narratives of the Presentation of Television at the World's Fairs in Paris (1937) and New York (1939)," *Historical Journal of Film, Radio and Television* 28, no. 3 (2008): 291–310; and Peter J.T. Morris, "'An Effective Organ of Public Enlightenment': The Role of Temporary Exhibitions in the Science Museum," in *Science for the Nation: Perspectives on the History of the Science Museum,* ed. Peter J.T. Morris (New York: Palgrave Macmillan, 2010), 228–264.

73. Franz Fuchs, "Die Fernsehsonderschau im Deutschen Museum zu München," *Radio, Bildfunk, Fernsehen für Alle* 16 (1937): 145.

74. In the 1943 drawing, the female secretary playing the vocal organ has been replaced by a male assistant. Further, the perceived object is no longer a static key but a car in motion. This latter change echoes the discursively shaped relationship between the car and television. Suggesting speed and ubiquity, both refer to the modern experience of "the annihilation of space by time."

75. Kahn, *Man in Structure and Function*, 530; emphasis added.

76. Kahn, *Man in Structure and Function*, 531.

77. Ross Melnick, *American Showman: Samuel "Roxy" Rothafel and the Birth of the Entertainment Industry, 1908–1935* (New York: Columbia University Press, 2012), 2.

78. Henry Jenkins, *Convergence Culture: Where Old and New Media Collide* (New York: New York University Press, 2008). For historical analysis of media convergence, see David Thorburn, Henry Jenkins, and Brad Seawell, *Rethinking Media Change: The Aesthetics of Transition* (Cambridge, MA: MIT Press, 2004); and Janet Staiger and Sabine Hake, *Convergence Media History* (New York: London: Routledge, 2009).

79. Paul Erker, "Die Verwissenschaftlichung der Industrie: Zur Geschichte der Industrieforschung in den Europäischen und Amerikanischen Elektrokonzernen 1890–1930," *Zeitschrift für Unternehmensgeschichte / Journal of Business History* 35, no. 2 (1990): 73–94.

80. William Uricchio, "Television as History: Representations of German Television Broadcasting, 1935–1944," in *Framing the Past: The Historiography of German Cinema and Television*, ed. Bruce A. Murray and Christopher J. Wickham (Carbondale: Southern Illinois University Press, 1992), 167–196.

81. The company was named after its founder, John Logie Baird. See Russell W. Burns, *John Logie Baird: Television Pioneer* (London: Institution of Electrical Engineers, 2000), 196.

82. Kilian J.L. Steiner, *Ortsempfänger, Volksfernseher und Optaphon: Die Entwicklung der deutschen Radio- und Fernsehindustrie und das Unternehmen*

Loewe 1923–1962 (Essen: Klartext-Verlag, 2005), 122.

83. "Unser sechzehntes Geschäftsjahr," *Der Bosch-Zünder. Zeitschrift für alle Angehörigen der Robert Bosch A.-G.* 15, no. 3 (March 1933): 34.

84. "Das fünfzehnte Geschäftsjahr," *Der Bosch-Zünder. Zeitschrift für alle Angehörigen der Robert Bosch A.-G.* 14, no. 9 (September 1932): 14.

85. Michael K. Buckland, *Emanuel Goldberg and His Knowledge Machine: Information, Invention, and Political Forces* (Westport, CT: Libraries Unlimited, 2006), 13.

86. [C.P.] Goerz, "1929–1939," *Hausmitteilungen aus Forschung und Betrieb der Fernseh Aktiengesellschaft, Berlin* 1, no. 4 (July 1939): 109.

87. Gerhart Goebel, "Das Fernsehen in Deutschland bis zum Jahre 1945," *Archiv für das Post- und Fernmeldewesen* 5, no. 5 (1953): 375–380.

88. Friedrich A. Kittler, *Gramophone, Film, Typewriter* (Stanford, CA: Stanford University Press, 1999), 243; and Friedrich A. Kittler, *Optical Media: Berlin Lectures 1999* (Cambridge, UK: Polity, 2010), 208. While the relation between military research and televisual development should not be underestimated, such general claims about television's genealogy risk veiling the plurality of historical conditions leading to the emergence of television from the 1880s on and should thus be read with the necessary caution. On the history of television during World War II, see Uricchio, "Television as History"; and Albert Abramson, "Television and World War II," in *History of Television, 1942–2000* (Jefferson, NC: McFarland, 2003), 3–17.

89. Steve J. Wurtzler, *Electric Sounds: Technological Change and the Rise of Corporate Mass Media* (New York: Columbia University Press, 2007), 15.

90. White, "The Attractions of Television," 79.

91. Judith Keilbach and Markus Stauffer, "When Old Media Never Stopped Being New: Television's History as an Ongoing Experiment," in *After the Break: Television Theory Today*, ed. Marijke de Valck and Jan Teurlings (Amsterdam: Amsterdam University Press, 2013), 80.

92. William Uricchio, "Television's Next Generation: Technology / Interface / Flow," in *Television after TV: Essays on a Medium in Transition*, ed. Lynn Spigel and Jan Olsson (Durham, NC: Duke University Press, 2004), 166.