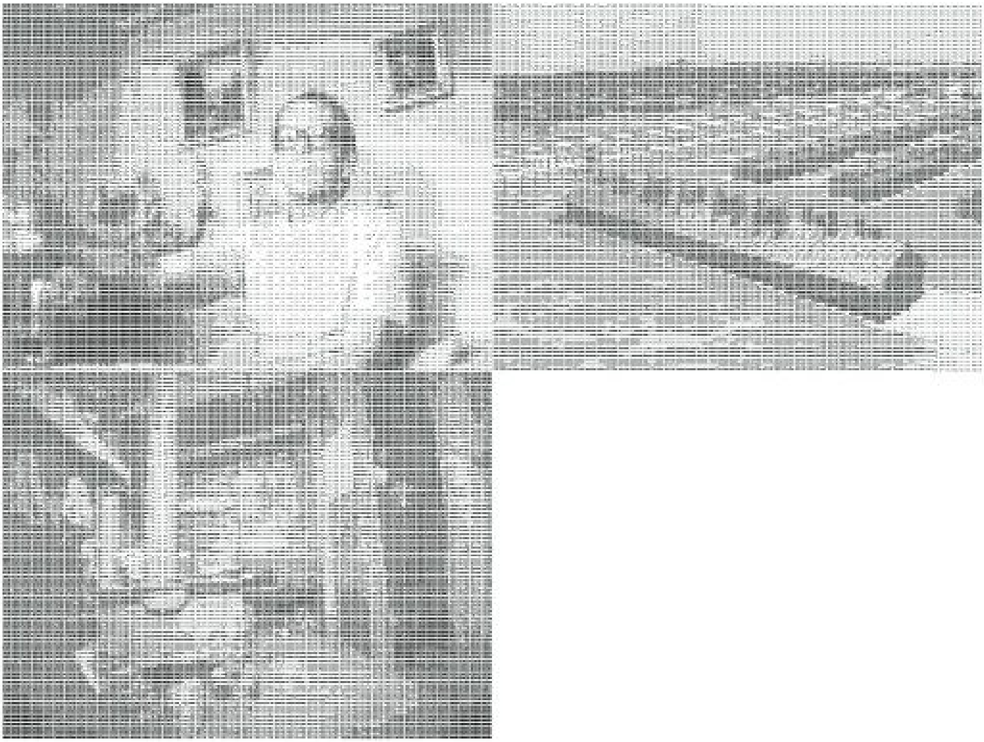

Simon Rothöhler

The Distributed Image

Stream | Archive | Ambience

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Translated into English by

Daniel Hendrickson & Textworks Translations

BRILL | FINK

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Introduction – *Transport Calculations*

The mobility of digital images takes place according to transport calculations. Inasmuch as these images consist of information that could not be employed visually without computation, their situation can be considered to be determined by logistics. Without a transport plan, without transition points and delivery protocols, no materializations in visual form could emerge from agglomerations of inscrutable numerical data. In order to be perceptible as movable visual elements that tend toward alterations of location and state, data must be packaged in appropriate container formats, funneled adaptively through networks, coded and processed specifically for visualization. The emergence, the manifestations, the movement patterns of digital images are in their very constitution dependent on computational operations, on a logistical interplay between various agencies adept at computation. In this, images are not so much sessile objects, necessarily fixed entities, as they are fluid processes—and distribution is precisely not a matter of subordinated, subsequent mobilization. For digital images are, in multiple respects, produced, inasmuch as and because they are directly distributable. This is causally linked to a multifaceted media logistics of the image, whose actants can likewise be said to distribute how they distribute because they are distributed.

Current visual culture is dominated by the output of »ubiquitous photography«[1] whose media-technical acquisition already enacts a transport calculation. This concerns light measurements and formalizes a transformation: photons that are conveyed as electrons, transcribed and stored as voltage values. The image data—initially deposited as quantities of electricity, kept ready in working memory, and finally mobilized in raster graphics—are calculated according to the transport plan before, during, and after. In the general public perception they are encompassed by parameters that attempt to quantify the global image traffic in the form of abstract estimates. While humanity had produced a total of 3.8 trillion photographic images by the beginning of the 2010s, there are thought to have been one trillion in 2015 alone.[2] These impressive numbers cannot be conceived concretely, and it is not even clear exactly how they are

* This book is a translation of the German original *Das verteilte Bild. Stream—Archiv—Ambiente* (2018). The text and the references have not been revised for translation.

1 Martin Hand, *Ubiquitous Photography*, Cambridge, UK: Polity Press, 2012.

2 Cf. Gerald C. Kane, Alexander Pear, »The Rise of Visual Content Online,« *MIT Sloan Management Review* (blog), Jan. 4, 2016, https://sloanreview.mit.edu/article/the-rise-of-visual-content-online/.

DOI:10.30965/9783846767771_002

calculated. Especially with regard to the wide range of image-based everyday practices, however, the assumption of an unabated and sustained proliferation of images seems exceedingly plausible.

As a phenomenon and motor of ›big data,‹ digital images that »have information«[3] (Claus Pias) are recording unbridled rates of growth. There seems to be no plateau of visual saturation in sight. On the contrary, the flow of images is becoming more comprehensive, easier to track, closer to ›real time.‹ Both computer-generated images without an optoelectronic prehistory of acquisition (that is, without measuring value equivalence) and those whose computability is still based on a visual capture that can, even »after photography,«[4] be called photographic at its core, flow equally as information through transmission channels that are agnostic in this respect. Image-based practices are entering into more and more fields of activity and are being habitualized as everyday communicative routines. At the same time, image technologies and their infrastructures contribute, more or less cryptically, to the systematic control of a growing number of specific societal areas—usually without any recognizable temporal delay, in so-called ›real time,‹ more and more often even beyond the faculties of human perception.

As long as available storage capacities, end user devices equipped with cameras, and visual sensory input in general continue to increase, there is nothing to indicate a tendency toward stagnation here. Projected global figures like those cited above could even be considered comparatively conservative assumptions about the current intensity in the distribution of visual culture. Not only because forms of data visualization that reduce complexity, which could likewise be discussed in terms of image theory, such as diagrams[5] or »iconized simulation images,«[6] are usually ignored, but also because all kinds of visual occurrences, generated automatically and without intent, which are increasingly associated with the Internet of things, are generally not taken into consideration as often as image-based instant messaging services, which are more present in the discourse of media studies, or the 400 hours of video material uploaded minute by minute on the platform of the market leader YouTube

3 Claus Pias, »Das digitale Bild gibt es nicht. Über das (Nicht-)Wissen der Bilder und die informatorische Illusion,« *zeitenblicke* 2/1 (2003), http://www.zeitenblicke.historicum.net/2003/01/pias/index.html.

4 Fred Ritchin, *After Photography*, New York: W.W. Norton & Company, 2009.

5 Cf. Sybille Krämer, »Operative Bildlichkeit. Von der ›Grammatologie‹ zu einer ›Diagrammatologie‹? Reflexionen zu erkennendem ›Sehen‹,« in: Martina Heßler, Dieter Mersch (eds.), *Logik des Bildlichen. Zur Kritik der ikonischen Vernunft*, Bielefeld: Transcript, 2009, 94–117.

6 Inge Hinterwaldner, *The Systemic Image. A New Theory of Interactive Real-Time Simulations*, Cambridge, MA: MIT Press, 2017.

alone. The fact that all these images can be not only constantly generated and saved, but also instantaneously sent and effortlessly multiplied, is also part of the complete picture of the flexibly aggregated mass of images that is coursing through the data circuits of visual culture: a constant transmission surrounded by metaphors of fluidity[7] that leads to a stream-like circulation of images, to incessantly reconfigured visual structures, to a ubiquity of digital images spread throughout society. What these images—whether ›viral,‹ underway in the multiplying forms of social media, or stored in distant memory banks without anyone seeing them—actually »want«[8] (W.J.T. Mitchell) seems at first, in view of their static profile values, to be quite unambiguous and mundane: to multiply, to be shared.

But simply attesting to this ubiquity does not get us particularly far. Is this a temporary interval in a tendency for image distribution that has been on the rise for centuries, or a qualitatively new stage of intensified dissemination? The history of the accelerated mobilization of images in massive quantities unquestionably does not begin with their being digitally fed into computer networks. This can be seen, for instance, in the work of Oliver Wendell Holmes, who in 1859 saw »enormous collections« of photographic forms emerging and gaining momentum: »There is only one Coliseum or Pantheon; but how many millions of potential negatives have they shed—representatives of billions of pictures—since they were erected! Matter in large masses must always be fixed and dear; form is cheap and transportable.«[9] Nearly a century later, in 1952, Lewis Mumford made a comparable assessment of what he observed as the »endless succession of images,« utilizing—much like Vilém Flusser at the beginning of the 1990s as well as many social commentators looking at our present moment, in which »bundled switching methods«[10] can rely on fiber optic cables—the metaphor of the flood: »We are overwhelmed by the rank fecundity of the machine [...]. Between ourselves and the actual experience and the actual environment there now swells an ever-rising flood of images which come to us in every sort of medium—the camera and printing press, by motion picture and by television. A picture was once a rare sort of symbol, rare

7 Cf. Matthias Bickenbach, Harun Maye, *Metapher Internet. Literarische Bildung und Surfen*, Berlin: Kadmos, 2009, 17ff.

8 Cf. W.J.T. Mitchell, *What Do Pictures Want? The Lives and Loves of Images*, Chicago: Chicago University Press, 2007.

9 Oliver Wendell Holmes, »The Stereoscope and the Stereograph,« *The Atlantic Monthly*, June 1859, 738–748, here: 742.

10 Vilém Flusser, »Bilderstatus« [1991], in Flusser, *Die Revolution der Bilder*, Mannheim: Bollmann, 1995, 81–94, here: 85f.

enough to call for attentive concentration. Now it is the actual experience that is rare, and the picture has become ubiquitous.«[11]

Shifts in the economics of attention notwithstanding, the acceleration of the image is not the exclusive privilege of technologically (re)producible visual forms and their media logistics. Working from the disciplinary viewpoint of art history, Jennifer L. Roberts has recently shown that transport histories can be used to explore even ›pretelegraphic‹ visual eras.[12] Roberts is concerned not only with mobilizing an »aesthetics of transmission« that becomes operative within the image or in perception, but also with the »material history of visual communication,« which experiences a transformative reconfiguration in the eighteenth century as visual objects—not least through altered material qualities of the physical image carrier, which ultimately transforms into a »flexible screen«[13]—become increasingly »easy to move,« developing into a novel form of transport goods. Because of the emergence of transport infrastructures that facilitate a wide variety of transfer relations between London and Boston, a painting like John Singleton Copley's *A Boy with a Flying Squirrel* (*Henry Pelham*) (1765) can be shipped across the Atlantic as a »long-distance picture«: »This process took muscle and it took time. It introduced the picture to what economic geographers call the friction of distance, exposing it to the risk of damage, spoilage, theft, or miscarriage and subjecting it to the contingencies of topography, seasonality, and territorial politics. It submitted the picture to the captivation of extrinsic transport and communications systems managed not by artists, patrons, or critics, but by customs agents, packers, drivers, couriers, postmen, and slaves.«[14] What has already changed at this point in time are the agents that carry, store, and surround the image as socio-technical

11 Lewis Mumford, *Art and Technics*, New York: Columbia University Press, 1952, 96. On the putative erosion of »attentive concentration,« see Petra Löffler, *Verteilte Aufmerksamkeit. Eine Mediengeschichte der Zerstreuung*, Berlin: Diaphanes, 2014.

12 Jennifer L. Roberts, *Transporting Visions: The Movement of Images in Early America*, Berkeley: University of California Press.

13 In his media and trade history, Matthias Bruhn gives an earlier beginning to the »development of mobile image carriers«: »The use of cloth for painting surfaces has been known since antiquity. In the Middle Ages it was still being used for banners or as an ersatz for woven carpets. As a surface for figurative painting, however, strung wooden panels were primarily used, which were sensitive to climate and transport. Around 1500 wood was therefore gradually replaced by canvas, above all in Italy (with Andrea Mategna or Sandro Botticelli), but only became common on the continent over a hundred years later. […] Due to the growing wealth of mostly bourgeois-mercantile classes, the transport of artworks across borders steadily increased throughout Europe« (Matthias Bruhn, *Das Bild. Theorie—Geschichte—Praxis*, Berlin: Akademie Verlag, 2009, 29).

14 Roberts, *Transporting Visions: The Movement of Images in Early America*, 1.

ensembles, distributing images throughout ever more open spaces in ever shorter time frames.

In terms of the logistics of the image, the general transport conditions of portrait painting in the eighteenth century—heavily labor-intensive, sent on sea voyages for months at a time, and received from afar—and the infrastructural requirements in place today for visual phenomena, which can be transferred instantaneously and in mass quantities via transoceanic fiber optic cables—such as the more than two million data sets of the Artstor Digital Library,[15] to keep to the field of art history—are of course separated by a vast historical-cultural, economic-technological distance. With the telegraphic and photographic inventions of the nineteenth century—which, in terms of media history, are connected with today's methods of trillionfold transmission of image data—a paradigm shift unfolds that fundamentally delegates both the production and the distribution of the image to technological processes. Having arrived in the digital present, images appear as more »easy to move« than ever, even if they circulate de facto over increasingly complex, generally less visible infrastructures—and in relation to these infrastructures pass through »shifting materialities.«[16]

Beyond proliferating transfer quantities and transfer times at the »speed of light«[17] that give the impression of being in real time, the present state of the distributed image, whose conditions of delivery and storage are the focus of this study, seems to be defined first and foremost by fundamentally different, namely algorithmically intervening transport calculations. Because digital image transmission works with data, with images whose transportation is calculated through information technologies, the semantic field of the homonym »logistics«[18] turns out to be quite appropriate—particularly from the

15 Cf. the Artstor homepage, https://www.artstor.org/.

16 Cf. Arlid Fetveit, »The Ubiquity of Photography,« in: Ulrik Ekman (ed.), *Throughout: Art and Culture Emerging with Ubiquitous Computing*, Cambridge, MA: MIT Press, 2012, 89–102, here: 96.

17 On the transmission of optical signals by fiber optic cables, Friedrich Kittler writes: »This sensational tautology of light becoming a transmission medium for light includes rather than excludes the possibility that the same speed of light also benefits all other signals. Besides television signals, optical fibers can also transport electronically converted acoustics, texts or computer data, and can thus be promoted to the position of a general medium, just as Hegel had already celebrated light« (Friedrich Kittler, *Optical Media: Berlin Lectures 1999*, trans. Anthony Enns, Cambridge, UK: Polity Press, 2010, 224).

18 Cf. in general Gisela Hürlimann, Frédéric Joye-Cagnard, Daniela Zetti (eds.), *Gesteuerte Gesellschaft. Logistik, Automatisierung und Computer in der Nachkriegszeit. Traverse 16*, Zurich: Chronos, 2009.

viewpoint of a work in media studies that is interested in questions of distribution. Viewed etymologically, the Greek *logistikós* (having to do with calculation) meets the French *loger* (to quarter, to accommodate). The former sees logistics as a calculation to be treated mathematically and as a subfield of philosophical logic,[19] while the latter initially referred to military apparatuses of provisions and supplies, which since the 1960s has been extended to economic phenomena that are more or less dependent on rationalization: to »all the operations of transporting, storing, and handing in the area of real goods,« which require »a flowing network of goods, materials, and energies to be formed«[20] and are thereby supposed to become more logically thought through, that is, ›more rational.‹[21]

Against this backdrop, the calculation of data processing in information technologies and its stream-like, seemingly continuous distribution through computer networks can be conceived as media-logistical flow management. The prerequisite for this is a terminological exchange. Along these lines, logistics research in media and cultural studies in recent years has addressed the prehistory of radar technology,[22] software and data centers,[23] warehouses and flow charts,[24] pirate infrastructures,[25] but also calendars, clocks, and towers.[26]

19 Cf. Rudolf Carnap, *Abriss der Logistik: Mit besonderer Berücksichtigung der Relationstheorie und ihrer Anwendung*, Vienna: Springer, 1929.

20 Ulli Arnold, »Logistik,« *WiSt* 3 (1986), 149–150, here: 150.

21 On etymology cf. Gabriele Schabacher, »Raum-Zeit-Regime. Logistikgeschichte zwischen Medien, Verkehr und Ökonomie,« *Archiv für Mediengeschichte* 8 (2008), 135–148, here: 136ff.; and Christoph Neubert, Gabriele Schabacher, »Logistik,« in: Tina Bartz, Ludwig Jäger, Markus Krause, Erika Linz (eds.), *Signaturen der Medien. Ein Handbuch zur kulturwissenschaftlichen Medientheorie*, Paderborn: Fink, 2012, 164–169, here: 164. On the ›logistical‹ encounter between the military and mathematics, cf. Monika Dommann, »Handling, Flow Charts, Logistik: Zur Wissensgeschichte und Materialkultur von Warenflüssen,« in: Philipp Sarasin, Andreas Kilcher (eds.), *Nach Feierabend. Zürcher Jahrbuch für Wissensgeschichte 7: Zirkulationen*, Berlin: Diaphanes, 2011, 75–103, here: 94f.

22 Judd A. Case, »Logistical Media: Fragments from Radar's Prehistory,« *Canadian Journal of Communication* 38 (2013), 379–395.

23 Ned Rossiter, *Software, Infrastructure, Labor: A Media Theory of Logistical Nightmares*, New York: Routledge, 2016.

24 Monika Dommann, »Wertspeicher: Epistemologien des Warenlagers,« *Zeitschrift für Medien- und Kulturforschung* 12 (2012), 32–50; and Dommann, »Handling, Flow Charts, Logistik.«

25 Brian Larkin, *Signal and Noise: Media, Infrastructure, and Urban Culture in Nigeria*, Durham, NC: Duke University Press, 2008.

26 John Durham Peters, »Calendar, Clock, Tower,« in: Jeremy Stolow (ed.), *Deus in Machina: Religion and Technology in Historical Perspective*, New York: Fordham University Press, 2013, 25–42.

The works of Gabriele Schabacher and Christoph Neubert in »transportation studies,« which are interested in terminological transfers between logistics and media theory approaches, refer, as does most current research, less to Virilio's previously widely cited writings from the 1980s,[27] than to actor-network theory (ANT). In ANT transport questions fundamentally appear as questions of transformation, and are thus a matter of relational categories.[28] Dynamics of mobility are associated not only with changes in location and state, but precisely also with »formally constant« stabilization effects that facilitate efficient distribution, as can be seen in the scientific usage of image-based »simplification procedures.«[29]

For Latour images operate in this context by both blocking and mobilizing: they link »the global and the local, the paper of the image with its circulation,« halting »inscription practices« and rendering them transferable

27 Cf. Benjamin H. Bratton, »Logistics of Habitable Circulation: A Brief Introduction to the 2006 Edition of *Speed and Politics*,« in: Paul Virilio, *Speed and Politics*, trans. Marc Polizzotti, Los Angeles: Semiotext(e), 2006, 7–25, here: 13. On logistical theorems in Harold A. Innis's work cf. Torsten Hahn, »Waterways. H.A. Innis' Kanufahrt zum Ursprung des Dominion,« in: Christoph Neubert, Gabriele Schabacher (eds.), *Verkehrsgeschichte und Kulturwissenschaft. Analysen an der Schnittstelle von Technik, Kultur und Medien*, Bielefeld: Transcript, 2012, 143–161; on Norbert Wiener cf. Case, »Logistical Media«; on McLuhan cf. Gabriele Schabacher, »Transport und Transformation bei McLuhan,« in: Till A. Heilmann, Jens Schröter (eds.), *Medien verstehen: Marshall McLuhans Understanding Media*, Lüneburg: Messon Press, 2017, 59–84.

28 On the relation between transport and transformation cf. Bruno Latour, »Train of Thought: Piaget, Formalism, and the Fifth Dimension,« *Common Knowledge* 8/3 (1996), 170–191; see also Christoph Neubert, Gabriele Schabacher, »Verkehrsgeschichte an der Schnittstelle von Technik, Kultur und Medien. Einleitung,« in: Neubert, Schabacher (eds.), *Verkehrsgeschichte und Kulturwissenschaft. Analysen an der Schnittstelle von Technik, Kultur und Medien*, Bielefeld: Transcript, 2012, 7–45, here: 25f.

29 Bruno Latour, »Visualisation and Cognition: Drawing Things Together,« *Knowledge and Society: Studies in the Sociology of Culture Past and Present* 6 (1986), 1–40, here: 16. See also Latour, »Die Logistik der immutable mobiles,« in: Jörg Döring, Tristan Thielmann (eds.): *Mediengeografie. Theorie–Analyse–Diskurse*, Bielefeld: Transcript, 2009, 111–144. On the connection between mobile transportability and formally constant immutability, which is expressed in Bruno Latour's concept of immutable mobiles, cf. Erhard Schüttpelz, »Elemente einer Akteur-Medien-Theorie,« in: Schüttpelz, Tristan Thielmann (eds.), *Akteur-Medien-Theorie*, Bielefeld: Transcript, 2013, 9–70, here: 33ff. Cf. also Christoph Neubert, »Innovation, Mobilisierung, Transport. Zur verkehrstheoretischen Grundlegung der Akteur-Netzwerk-Theorie in Bruno Latours ARAMIS, OR THE LOVE OF TECHNOLOGY,« in: Neubert, Gabriele Schabacher (eds.), *Verkehrsgeschichte und Kulturwissenschaft. Analysen an der Schnittstelle von Technik, Kultur und Medien*, Bielefeld: Transcript, 2012, 93–140.

to »transformation networks.«[30] The technical drawings, maps, or diagrams he examines become operative above all through their capacities to convey »inscriptions« as compact, easily mobilizable and combinable information storage. Ultimately, from this perspective, image transport primarily functions as a technique to establish power through »epistemic superiority.«[31]

Generally speaking: in the dialogue between media and logistics theory, news, messages, information appear as goods modulated by transport, circulating by means of transmission operations whose processuality can be conceived as a form of traffic. Even the shared media and infrastructure histories of traffic and messaging systems suggest the connection between technologies of transport and those of information transfer.[32] Seen in this way, data packets become distribution commodities, whose regulation, monitoring, and circulation run via the activity networks of distributed, interacting actants. The terminological offerings of logistics are therefore certainly not inappropriate for a »metatheory of traffic,«[33] for instance also in making automated packet switching in computer networks and self-regulating processes of the Internet of things accessible to media theory.[34]

The distributed image can be regarded as a logistical phenomenon insofar as it is operationalized in the form of data traffic and thus cannot be reduced to one location, a single medium, a primarily responsible agent, a central agency. Logistics primarily refers to the variety and interwovenness of the actants operationally involved in this distribution, which range from infrastructures of data distribution such as data centers and transoceanic cable networks to common container formats such as Matroska (MKV), standardized image compression norms such as JPEG, and various streaming protocols, to the human end users, who are still equipped with the initiative to work with the image in a practical way, and their demand for images, which is increasingly channeled into social media. If at its core logistics can be understood as those practices »that fall between production and consumption,«[35] the distributed

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30 Bruno Latour, »Arbeit mit Bildern oder: Die Umverteilung der wissenschaftlichen Intelligenz,« in: Latour, *Der Berliner Schlüssel. Erkundungen eines Liebhabers der Wissenschaften*, Berlin: Akademie, 1996, 159–190, here: 182ff.

31 Friedrich Balke, »System- und Netzwerktheorien: Bilder in Umgebungen,« in: Stephan Güntzel (ed.), *Bild. Ein interdisziplinäres Handbuch*, Stuttgart: J.B. Metzler, 2014, 109–117, here: 114ff.

32 Cf. Christoph Neubert, »Verkehr,« in: Tina Bartz, Ludwig Jäger, Markus Krause, Erika Linz (eds.), *Signaturen der Medien. Ein Handbuch zur kulturwissenschaftlichen Medientheorie*, Paderborn: Fink, 2012, 323–328, here: 323f.

33 Schabacher, »Raum-Zeit-Regime,« 147.

34 Cf. Schabacher, Neubert, »Verkehrsgeschichte,« 24f.

35 Dommann, »Handling, Flow Charts, Logistik,« 75.

image can furthermore provide indications as to what it means when logistical calculations migrate and encroach, so to speak—that is, when they begin to have a sustained effect on the production and use of the transported goods.

What is inevitably set in motion within such a scenario, what gets distributed along with all this, however, is the concept of the image.[36] For instance, in the introduction to a collection of writings on »Imagery in the 21st Century« we can read: »Images cannot be reduced to a specific technology (gravure printing or X-ray), to genres (portrait or silhouette), to practices (taking photographs or programming), to specific instruments or devices (pencil or microscope), to symbolic forms (perspectives), to a social function (edification or diagnosis), to materiality or symbolism—and yet images operate in all of these.«[37] If we follow this cursory inventory of a »plurality of visual appearances,«[38] extensively differentiated even typologically and by definition not easily lockable, the question arises as to how to establish an analytically productive perspective, how it might be possible to find at least an entry point that could help to sort out and narrow down the field of investigation. In this respect, to understand the digital image ›logistically,‹ as distributed, would suggest, in the sense outlined here, taking transportation and storage processes as modes of

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36 Already against the backdrop of the broader transdisciplinary debate that began in the 1990s about a »turn to the image« largely promoted by the changes in digital media—according to which the image is on the one hand ubiquitous, hegemonic, and on the other epistemically dubious, precarious, susceptible to manipulatively calculated attacks—the question persistently arose as to how the image, through new means and expanses of circulation, reformats its forms of practice and ultimately also the sphere of the visual in culture as a whole. For an overview of the debate around the iconic or pictorial turn and the discursive field that emerged between the science of images (*Bildwissenschaft*) and visual culture studies, cf. Marius Rimmele, Klaus Sachs-Hombach, Bernd Stiegler (eds.), *Bildwissenschaft und Visual Culture*, Bielefeld: Transcript, 2014; for a review see also Beat Wyss, »Die Wende zum Bild: Diskurs und Kritik,« in: Stephan Güntzel, Dieter Mersch (eds.), *Bild. Ein interdisziplinäres Handbuch*, Stuttgart: J.B. Metzler, 2014, 7–15. The degree to which the »turn to the image« is associated with a practical turn in the theory of science can be seen in Monika Dommann, »Vom Bild zum Wissen: eine Bestandsaufnahme wissenschaftshistorischer Bildforschung,« *Gesnerus* 61 (2004), 77–89.

37 Oliver Grau, Thomas Veigl, »Introduction: Imagery in the 21st Century,« in: Grau, Veigl (eds.), *Imagery in the 21st Century*, Cambridge, MA: MIT Press, 2011, 1–18, here: 7. On scientific images, cf. Horst Bredekamp, Birgit Schneider, Vera Dünkel (eds.), *Das Technische Bild. Kompendium zu einer Stilgeschichte wissenschaftlicher Bilder*, Berlin: Akademie Verlag, 2008; for an image-theoretical approach to game studies, see Stephan Güntzel, *Egoshooter. Das Raumbild des Computerspiels*, Frankfurt/Main: Campus, 2012.

38 Dieter Mersch, Oliver Ruf, »Bildbegriffe und ihre Etymologien,« in: Dieter Mersch, Stephan Güntzel (eds.), *Bild. Ein interdisziplinäres Handbuch*, Stuttgart: J.B. Metzler, 2014, 1–7, here: 1.

the continuous processing of image data, that is, focusing on the mobility and calculability of the image, the significance of the intersection between images and image data, the relationship between streaming and storing. This will also be my concern in the following.

For Peter Osborne, who approaches the »distributed image« against the backdrop of a philosophical examination of post-conceptual art, distribution is on the one hand a characteristic of the informational structure of pictorial data visualization, which is distributed in the information-technological form of fundamentally homogeneous pixels at concrete locations such as screens—and in this preferentially creates ›photographically‹ coded appearances: »the current historically dominant form of the image in general.«[39] To this is added a further mobilization: »There is an inherent tendency in the distributive networks of the digital image to move the image on. [...] The digitally produced and distributed image ›lives‹ (has social actuality) increasingly, through its relations to and *transformation into* other images, within a globalized image-space.«[40] Qualified by the contingent relationship between image file and image display, which also facilitates variably distributed computer graphic materializations on the basis of invariable data sets, digital images fundamentally appear and take form in relation to distribution parameters. Over the course of repeated regenerations, the boundaries between images also become more permeable, as the quantifiable information in the images is transported through the same data channels, exchanged and adjusted with regard to the ongoing transmission calculations, which migrate and adapt themselves. The »global image-space« is not a stable, accessible building, but a continuously replenishing data pool requiring calculation, a non-binding, algorithmically implemented state that is permanently reconstructing itself, an intermediary result that cannot be identically reproduced in its information-technological details, which calculates streaming movements of data and connects them with ever new requests for elements of visual culture.

39 Peter Osborne, »Infinite Exchange: The Social Ontology of the Photographic Image,« *Philosophy of Photography* 1/1 (2010), 59–68, here: 59.

40 Peter Osborne, »The Distributed Image = Das verteilte Bild,« *Texte zur Kunst* 99 (Sept. 2015), 74–87, here: 84 (italics in the original). Winfried Gerling speaks in a similar sense with regard to the social media commodification effects of »mobile and mobilized images«: »[P]ictures are becoming ever more mobile: photographs are moving images in the context of social media; they are moved on screens and pushed to be updated both automatically and by the user. Due to the constant urge for updating, images are taken for consumption rather than for concentrated observation« (Winfried Gerling, »Moved Images—Velocity, Immediacy and Spatiality of Photographic Communication,« in: Mika Elo, Merja Salo, Marc Goodwin (eds.), *Photographic Powers*, Helsinki: Aalto ARTS Books, 2014, 287–307, here: 292).

Viewed empirically, this culture is dominated by phenomena that, according to Claus Pias, in a certain sense do not exist at all or exist only as a »semantic disturbance«[41] of analogue display: digital images. Siegfried Kracauer had already written—with regard to raster pictures in the »illustrated newspapers« of the 1920s, which also consisted of discrete elements—that the digital as such could not be seen pictorially: »The picture, however, does not refer to the dot matrix.«[42] But we can also say, along with Pias, that the digital images of the present—whose individual points correspond to numerical values that, as units of information, can be discretely addressed, calculated, manipulated—do not not exist, strictly speaking, but exist doubly: as invisible, stored code, which computer programs can also use for calculations beyond the task of transporting and displaying an image, and as a visualized form, which can be recognized and examined as images by human perception. The transfer from the first state into the second may indeed be contingently updated, and may to a certain degree appear dispensable from the viewpoint of the computer, which does not need the visual output in order to be able to make calculations with the image data.[43] If there is no pictorial visualization, on the other hand, information (and resources for action) are also lost, which can be shown, for instance, in light of the still limited machine-readability of the image, as will be discussed below.

Images, writes W.J.T. Mitchell, »have always given form to information«[44]—which, in the context of digital data distribution, also renders them unique mediators in media history: »If the ones and zeros did not add up to an image that massages the familiar and traditional habits of the human sensorium, it is unlikely that the digital revolution would have gained any traction at all.«[45] The persistence of photographic conventions[46] evident in the digital image traffic of the present era should also be understood against the backdrop of our well-rehearsed sensory habits. From this perspective, digital images appear as forms determined by information, which, if uncalculated, remain abstract, but are in principle also calculable regardless of their being visually played out, or

41 Pias, »Das digitale Bild.«

42 Siegfried Kracauer, »Photography« [1927], in: *The Mass Ornament: Weimar Essays*, trans. Thomas Y. Levin, Cambridge, MA: Harvard University Press, 1995, 47–64, here: 47.

43 Cf. Kittler, *Optical Media*, 293ff.

44 W.J.T. Mitchell, »Image,« in: Mitchell, Mark B.N. Hansen (eds.), *Critical Terms for Media Studies*, Chicago: University of Chicago Press, 2010, 35–48, here: 46.

45 Ibid., 45.

46 Sarah Kember has spoken in this sense of the »endurance of photographic codes and conventions« (Sarah Kember, »Ambient Intelligent Photography,« in: Martin Lister (ed.), *The Photographic Image in Digital Culture*, London: Routledge, 2013, 56–76, here: 57).

their perceptibility to the senses. Birgit Schneider, in her discursive history on the tension between code and form,[47] which during the theoretical debates of the 1990s had once again become virulent in ontologizing rhetoric as a »history of losing reference and materiality,«[48] emphasized that it is ultimately not the ontological status of digital images that is decisive, but what can be done with them operationally: »[T]he discretized, digital state of data and images provides the precondition for a much more far-reaching consequence, as it allows for special access to data through programs, making images accessible to technological processing. The uniqueness of digital images lies in their operationality and processability.«[49] These expanded operational opportunities are used, for instance, by image editing programs, in order to reconfigure and manipulate the phenomenal appearances of the image on the elementary level of individual pixels. In terms of information technology, however, the addressability of discrete picture elements can be discussed not only with regard to what in the broadest sense can be called a design-manipulative intervention of complex software,[50] but also, as will be shown in the following, in relation to those dimensions of technological processing that have to do with distribution agendas.

With regard to the relation to reality—which, in the case of both digital images and their analog predecessors, is fundamentally less dependent on imaging processes than on the discursive practices through which they are circulated—it can also be observed that digital images are in a novel way able to be processed referentially, as traces, not despite, but rather because of their

47 Birgit Schneider, »Wissenschaftsbilder zwischen digitaler Transformation und Manipulation. Eine Anmerkung zur Debatte des ›digitalen Bildes,‹« in: Martina Heßler, Dieter Mersch (eds.), *Logik des Bildlichen. Zur Kritik der ikonischen Vernunft*, Bielefeld: Transcript, 2009, 188–200, here: 191.

48 Johanna Drucker has addressed this relationship in the form of a critique of digital ontologies: Against the mythology of »pure code« (as an idealized concept of an immaterial »mathesis«) she understands digital images as »material embodiments,« which emerge from the oppositional logical of »graphesis« (»knowledge manifest in visual and graphic form«; cf. Johanna Drucker, »Digital Ontologies: The Ideality of Form in/and Code Storage—or—Can Graphesis Challenge Mathesis,« *Leonardo* 34/2 (2001), 141–145; and Drucker, *Graphesis: Visual Forms of Knowledge Production*, Cambridge, MA: Harvard University Press, 2014).

49 Schneider, »Wissenschaftsbilder,« 194.

50 Cf. the chapter »Inside Photoshop« in: Lev Manovich, *Software Takes Command*, New York: Bloomsbury Academic, 2013, 124–146. For a glimpse into current directions in manipulation in the context of machine learning (»AI-assisted deepfakes«) using the example of »face-swap porn,« see Samantha Cole, »Everyone Is Making AI-generated Fake Porn Now,« *Motherboard: Tech by Vice* (blog), Jan. 24, 2018, https://www.vice.com/en/article/bjye8a/reddit-fake-porn-app-daisy-ridley.

distributed informationality. For instance, image-forensic projects such as those of Bellingcat[51] and Forensic Architecture, which construct valid chains of evidence and »architectural image complexes«[52] from user-generated images, distributed on social media, and sometimes excessively reproduced, are based precisely on the algorithmic operationalizability of digitally stored image data.[53]

The information that digital images, in contradistinction to non-digital images, carry with them alters their logistical condition. How images that are generated and administered through information technology can be distributed and stored, how one can take them, their distribution, their being distributed, into account, what the transport calculations mean for image archives and visual environments, and what media-archaeological traces of the technological history of image distribution exist and continue to have an effect in the data storage of the present—these are the themes of the present study. To understand the image as distributed, as shared, leads to infrastructures, agents, processes of transmission, to the interface between images and transport data, to the question of how streams relate to storage, and what this means for image archives that can be transmitted ›in real time.‹

However, because the image in fact does not solely refer to the »dot matrix,« to its technical features, the distances to the image *as image* in the following will need to be scaled to different degrees. Code and form are equally interesting, but with varying emphasis. At times the image will give way to a media-technical perspective on the processes of its datafication, while other passages will be concerned with deriving media-historiographical information precisely from the ›exterior‹ of data that is accessible to the senses, from visual phenomenalizations, because these, from the viewpoint of human practices of perception and interpretation, continue to generate one meaning or

51 Cf. the Bellingcat website, https://www.bellingcat.com.

52 Eyal Weizman, *Forensic Architecture: Violence at the Threshold of Detectability*, New York: Zone Books, 2017.

53 Regarding the works of Forensic Architecture, Roland Meyer has noted that they make clear »how little the dichotomy of recording and simulation, of ›computed‹ and ›computer-generated‹ images, which has long defined the debate about digital images, does justice to today's visual practice. Rather, in the production of ›evidence assemblages‹ and ›architectural image complexes‹ indexical recording and data-based simulation are entangled with one another in nearly every step of production. Positions of virtual cameras and computed trajectories of shots are synchronized with photographically recorded movements of bodies in space, virtual models of light conditions and cloud formations are compared with the available visual image information« (Roland Meyer, »Asymmetrien der Auflösung,«*Cargo: Film/Medien/Kultur* 34 (2017), 70–73, here: 73).

another—including those meanings that lead into the distribution history of the image. To this end, case studies on photographic and videographic digitizations can serve as exemplary close-ups, in order to dissect not only media-archaeological stages of technological image distribution, which find their continuation in today's digital image practices, but also institutional, bureaucratic, discursive histories that circulate through the material.

The logistical systems that ›fluidly‹ move and calculate data sets are thus as a whole just as relevant as the question of messages, whose information, which can be addressed by media studies, is not transported into the present as sets of numbers, but in the form of an image. To put it another way: the question of the image can neither be answered exclusively in terms of a theory of infrastructure, nor abandoned in favor of an ontologically grounded universal data theory. The aforementioned operationality and processuality at play here should thus first be examined in terms of distributive parameters—without losing sight of the image as image.

It is nonetheless constitutive of the digital images in question that they are distributed by means of computer graphical dot matrices and networks, and are transported and perceptible under these conditions. At the other end of the spectrum, where the form of the image tends to be neutralized by media technology, the question arises as to where it is becoming apparent that the proliferation of visual capture, the sheer magnitude of image data created and distributed worldwide every second, leads to algorithmic routines that disregard the image as image not only theoretically, but also effectively and pragmatically. This does not simply refer to the channeling and sorting done on social media or the hierarchical effects of hegemonic search engines. Rather, at the horizon of the distributed image, its dissolution, a continual diffusion in a certain sense becomes apparent—and is already taking place when image data are automatically fused and processed in sensory networks, when they are consigned, almost ›without image,‹ to the ambience of ›ubiquitous computation,‹ marketed within the attention economy, completely and utterly calculated.

The route planned for this discussion is structured as follows:

The first part, *Stream—Data Traffic*, explicates in more detail the digital media logistics of the distributed image in three steps. The infrastructural design of the transport channels and the algorithmic calculations at work in them (I.1), the various levels of the associated datafication of the image (I.2), the constitutive significance of the processes and agendas of data storage involved in image data traffic, despite the emphasis on its stream-like quality (I.3)—these topics are developed as three interdependent dimensions whose media-theoretical contours will help to define more closely how, and to what degree, the digital image is distributed.

The second part, *Archive—Media Historiography*, follows up with the question of how the transfer processes of stream-like image data distribution relate to the intentions of archival storage institutions (II.1). Viewed pragmatically, digital image archives are initially distributed insofar as they enable remote access. Collections are transcribed, ›unconstricted,‹ newly suitable for distribution. The architecture of media technology in the depots constructed for this purpose, whose data can then be calculated ›granularly,‹ leads to networked archives, which are logistically linked with the current standards and protocols of ›ubiquitous‹ data storage, but these are applied to the transport of institutionally encoded historical information. Following a review of the complex debates in media and cultural studies about the »archival turn,« we will then examine concrete image data sets *as actual images*. This will be based on two digitized archival holdings: the NYC Department of Records and the United States Holocaust Memorial Museum. The case study materials comprise a series of digitized photographs from the 1910s, which were first produced at crime scenes by forensic specialists from the NYC Police Department and later transported into the agency's bureaucratic working storage, and several 16mm films that were almost completely unknown until recently, but have also been digitally transcribed and are now easily accessible via video streaming in a digital archive of outtakes, containing Claude Lanzmann's encounters with German SS men in the 1970s, which were also operationalized in a particularly complex way in terms of media logistics.

These materials were selected for a variety of reasons. The chapter on the Long-Distance Photographs (II.2) of the New York Police offers an opportunity to examine the distribution of images in the context of the bureaucratic desire to collect data, which already focused on photographic image archives as early as the nineteenth century in Alphonse Bertillon's department of the Prefecture of Police in Paris. The distribution history of selected crime scene photographs, which can be reconstructed as media history, deals with the phases of the photographs' ›de-datafying‹ and ›re-datafying,‹ which transported the images first into popular culture and art, and then, in a certain sense consolidated as historical documents, into digital archives; these phases can be read, on the one hand, in terms of discourse history. On the other hand, this chapter is also interested in the media-archaeological trails that lead from the technological scan processes of today's retro-digitization to photo-telegraphic operations, which the Berlin physics professor Arthur Korn promoted in 1926 at the international police congress in Weimar Republic Berlin as an accelerated image transport medium. He intended to show the representatives from various agencies gathered there how they could use this invention to send visual information about criminals on the run in the form of wanted posters and mug shots or crime scene forensics.

In the following chapter, High Frequency Videos (II.3), the focus then turns to archival materials that belong to a historiographic complex that has triggered a debate in image theory unlike any other. The historical and cinematic point of reference for this discours—which began with the images of the Allies liberating concentration camps in 1944/45 and, often ontologically charged, revolved around the relationship between visual documents and the historical event of the Holocaust—is Claude Lanzmann's documentary *Shoah*, released in 1985. The visual archive that surrounds this film amounts to more than 250 hours of recordings and is now being streamed out under the technological conditions of the compression standards and transfer protocols described in the first part of this study. This fact is addressed in this chapter, on the one hand, with regard to the distribution history of the entire visual archive of the Holocaust, which can also be read in terms of media historiography. From the viewpoint of this study, the fact that a large portion of these precarious archival images, often classified as ›iconically‹ abstracted—which were initially introduced as material evidence in legal trials, then recycled for decades in television and popular culture—now circulate as digital matter on commercial video platforms, but also in the digital image archives of institutional agencies, raises, among other things, the twofold logistical question of what it means that these images (and their information) have become both newly distributable and also accessible to algorithms, and thus can be brought into the image-related agendas of the digital humanities, such as models of a ›distant viewing.‹ The selected outtakes from *Shoah*—which do not contain photographic images of crime scenes, but rather videographic images of perpetrators, images that have thus far largely escaped the attention of media studies and historiography—are furthermore of particular interest because their creation in the German provinces of the late 1970s is due to what at the time was a highly advanced media logistics that enabled the clandestine production of visual signals, which had to be distributed ›at high frequency‹ even before they could be stored.

After this examination of the distribution histories of photographic and videographic digital objects, which is argued at varying scales, but nonetheless tends to remain ›near‹ to the digital image as a visual form, the third part, *Ambience—Sensory Networks*, concerns a somewhat contrary dynamic of recent image data traffic, namely, one that is in a certain sense ›imageless.‹ While the operativity and breadth of non-human storage readings are tested selectively in the context of the ›digital humanities,‹ they are already included in continuous implementation in certain usage areas of the Internet of things. The first chapter (III.1) is concerned with examining the related discussion about »ubiquitous computing« and »smart environments« pragmatically as well as epistemologically with respect to its visual-sensory approaches. The ›place‹ of digital image acquisitions outlined in this way then raises the question (III.2) of how the technological operations of images are to be understood from the perspective of media studies—operations that are indeed achieved by means of a visual capture, but first and foremost capture and store sensory environmental data whose logistical value appears as decoupled from any manifestation in the form of an image.

Whether the automatisms that extend into the media-technical ambience speak for an impending hegemony of ›calm images‹—whose data are acquired ubiquitously and distributed automatically, but are not viewed as images—seems to have not yet been decided. Regardless of this, we can say: even those digital images that continue to have human agents involved in their distribution and distributedness no longer circulate free of transport calculations.

I

Stream
Data Traffic

I.1 Distributing

Logistics deals with questions of distribution. How do we move something from A to B? How is transportation organized, and the route? How do we ensure that the delivery reaches its destination undamaged, in an organized and timely fashion? In order for something to appear ›everywhere‹ and ›in real time,‹ it must be accordingly distributable. We can therefore assume: the much-touted ubiquity of the digital image is an effect of its distributive versatility. The mobility of contemporary image traffic is realized in accordance with infrastructures and protocols of digital media technology that control the appearance of images algorithmically. This brings me to my initial questions: What are the calculations of distribution? How are images formatted as transport goods and what can be said about the nature of the transmission channels? What interwoven processes regulate the logistics of digital image traffic?

The question of distribution stands at the beginning of this study because we are dealing with an image that is distributed in a new way—a computable image, mobilized in multiple ways so as to be constantly moved onward. The empirical scope, intensity, and complexity of this distribution generates a raster-graphic-based stream of images that provides a wide variety of media-ecological spheres with bitmap material, loading displays, interfaces, environments with visual culture. Each individual stream-particle is regulated and can be logistically addressed and described by network protocols and codecs. The media agencies that enable particular digital data sets to temporarily become something taking on the iconic manifestation as ›image‹ within the flow of algorithmic performances are also first of all: distributed.

From the perspective of basic network protocols this is a matter of the minutely structured, highly computed transfer of datagrams, which are transmitted according to the distributional laws of packet switching. In order for a message to be distributed via computer networks, it must first be divided into basic transfer units and then put back together again at the destination. Transport routes, like transport goods, are distributed—the former over network nodes, the latter in data packets. Their dissemination generates an ostensibly uninterrupted stream of data, which is impossible to capture with common concepts of immateriality and ephemerality, or with the topoi of any sort of floating and traceless docking. A media format that translates data transmission into image circulation—and is responsible for a rapidly growing portion of the volume of global data traffic—expressly identifies this

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particular mode of transmission with a technical term that can be discussed as »time-critical«[54]: real-time streaming.

Streaming first of all denotes a general method of data distribution. Although transmission and playback processes do not completely coincide in this method, they are very closely interlinked. The time-related data material is processed and visualized while further components of the whole packet (which is only conceived as such in retrospect) continue to be received. From the viewpoint of the receiver, streaming has no immediately evident functionality in terms of storing data in memory beyond certain processes of caching. Within the conditions of computer networks, the respective operation occurs through a technically mediated simultaneity, which can be distinguished from both classical and so-called progressive downloading of a file primarily in that no complete copy of the data set exists at any point on the side of the client. It streams out and flows away again: a dual movement—nowadays usually in an adaptive bitrate format[55]—which is moderated through the transport channel and has only been able to be processed by the computing power and cache capacity of generally available end devices since the mid-1990s. Streaming thus avoids more extensive memory requirements of client usage through a process of transmission that not only continuously requests, distributes, and receives media server data, but also continuously discards it. A form of ›liveness‹ is therefore present even when the content—typically audiovisual, for my purposes—is not a live feed, but a comparatively consolidated data set (such as video on demand). But in a certain sense this, too, is not so much securely stored as permanently waiting: on server requests that are meant to be responded to instantaneously and just as quickly forgotten again. The logistical architecture thus addresses a dynamic standby position, which is conceived as fundamentally ready to distribute and whose primary ›liveness‹ is the real time of a transmission with adaptively switchable replay automatisms with no download. Already at this point it becomes clear that the »third,

54 Cf. Axel Volmar (ed.), *Zeitkritische Medien*, Berlin: Kadmos, 2009.

55 »Adaptive bitrate streaming […] is a technique wherein a sender encodes a video at a variety of different quality levels. […] [S]oftware on the viewer's computer senses the quality of the network connection and acts as a switch directing the server to send a lower-quality version of the requested content when the network is busy, conserving network capacity« (Christian Sandvig, »The Internet as Anti-Television: Distribution Infrastructure as Culture and Power,« in: Lisa Parks, Nicole Starosielski (eds.), *Signal Traffic: Critical Studies of Media Infrastructures*, Champaign: University of Illinois Press, 2015, 225–245, here: 233).

neglected function of media,«[56] the processing of »relevant data,«[57] to use the pertinent phrase provided by Friedrich Kittler, is so profoundly embedded in the transport channel in this process that transmission and processing overlap to a certain degree in essential respects—insofar as this includes, for instance, the significance of the compression algorithms involved and the now standard continuous calculation of connection quality. ›Real‹ in the real-time protocol family,[58] which was originally exclusively responsible for streaming media but has now partly been superseded, is to this day a procedure of realization that guides and controls how the arrival of packets is temporally organized. With audiovisual signals, especially during a live stream (such as videotelephony, for instance), the client's processing services have to be carried out with no time lag and in the right sequence. The real time to which streaming protocols are sensitized, as opposed to other network protocols, refers to this data-grammatical sequencing. Because successfully transported server data, in the case of such multimedia streams, are supposed to be processed instantaneously, traditionally by client plug-ins, there is in general very little tolerance for latency. Without data distribution structured in real time—that is, efficiently compensating for delayed transmission or the need for repetition due to defects or losses in the packet during transmission—the conditions for coherence codified in the time-based media of a live stream cannot be sufficiently stabilized in their transmission technology (with on-demand content there is more leeway for buffering cache storage). The critical point is that ›real time‹ indicates the relative imperceptibility of the transmission process, of the transmission and

56 Hartmut Winkler, *Prozessieren. Die dritte, vernachlässigte Medienfunktion*, Paderborn: Fink, 2015.

57 Friedrich Kittler, *Discourse Networks, 1800–1900*, trans. Michael Metteer, Stanford: Stanford University Press, 1990, 369.

58 Strictly speaking there are three network protocols—Real Time Transport Protocol (RTP), Real Time Transport Control Protocol (RTCP) and Real Time Streaming Protocol (RTSP)—which as a rule are run via the User Datagram Protocol (UDP), because this provides a higher data throughput than the more reliable, but slower Transmission Control Protocol (TCP), which also reacts to packet loss with insistent timeouts/retries (cf. Martin Warnke, *Theorien des Internet zur Einführung*, Hamburg: Junius, 2011, 76ff). Thanks to expanded broadband capacities, TCP-based HTTP Live Streaming (HLS) is now widely used, which has the advantage, among other things, of ensuring greater transfer security with a more economically efficient operation, and also of integrating the aforementioned adaptive bitrate streaming, thus being able to react flexibly to fluctuations in bandwidth instead of abruptly interrupting the stream or constantly having to buffer. Apple's HTTP Live Streaming, developed as an alternative to Flash Video, is the de facto standard today due to its efficient compatibility with many browsers and mobile devices (the alternatives to this are MPEG Dash as well as proprietary protocols such as Adobe's HTTP Dynamic Streaming or Microsoft's Smooth Streaming).

computation time, is therefore »pragmatically synchronous«[59] and represents a relational category.[60] Perceptual aspects are above all significant insofar as ›real time‹ is manifest not least as reaction time, which technically speaking nonetheless does not allow it to become real time.[61]

Sean Cubitt has described and theorized what the implied transmission economy means for digital images in terms of the difference between »recorded and real-time media.« The latter is characterized less by the possibility of a liveness that can be understood referentially (now/elsewhere), than by the fact that the transmission process analyzes, disassembles, and finally rewrites step-by-step perceptual data that are themselves, like audio and video signals, composed temporally. Viewed in terms of media archaeology, this media-technical temporalization of data streams that »form an environment of audiovisual signals«[62] is nothing new. »Dot-scanned wire photography and broadcast television moved toward live pictures [...]. The scanning principle [...] does not provide a whole, complete image at any one moment: each image contains the principle of change in itself.«[63] This principle of discretization,[64] beginning at the elemental level of the image, is therefore not disrupted in the computer-network-based forms of transmission, but rater continued and deepened:

> In digital images, where pixels act in the same way as film frames but much smaller and in much swifter succession, the frame itself is a

59 Winkler, *Prozessieren*, 198.

60 »[R]ealtime concerns the rate at which computational processing takes place in relation to the time of lived audio-visual experience. It entails the progressive elimination of any perceptible delay between the time of machine processing and the time of conscious perception« (Adrian Mackenzie, »The Mortality of the Virtual: Real-Time, Archive and Dead-Time in Information Networks,« *Convergence: The International Journal of Research into New Media Technologies* 3/2 (1997), 59–71, here: 60).

61 As Wendy Chun has persuasively argued: »In computer systems, ›real time‹ reacts to the live: their ›liveness‹ is their quick acknowledgment of and response to users' actions. Computers are ›feedback machines,‹ based on control mechanisms that automate decision making. As the definition of ›real time‹ makes clear, ›real time‹ refers to the time of computer processing, not the user's time. ›Real time‹ is never real time—it is deferred and mediated« (Wendy Hui Kyong Chun, *Updating to Remain the Same: Habitual New Media*, Cambridge, MA: MIT Press, 2016, 79).

62 Stefan Heidenreich, *FlipFlop. Digitale Datenströme und die Kultur des 21. Jahrhunderts*, Munich: Hanser Verlag, 2004, 58.

63 Sean Cubitt, *The Practice of Light: A Genealogy of Visual Technologies from Prints to Pixels*, Cambridge, MA: MIT Press, 2014, 235.

64 Cf. II.2 (Discrete Distribution).

> temporal phenomenon. […] [T]his efflorescence of image particles and microtemporalities within the frame risks shattering the unity and discretion of the image. Coherence has to be constructed after the event by applying massively reductive processes to the frame. Coherence is achieved then by nominating as redundant the mass of detail, color, and nuance that human observation is capable of. Instead, the task of observing is first modeled on a good-enough solution for an imaginary statistical norm of perception and then the process of selecting what to observe is automated. […] [B]ecause each frame and each pixel or group thereof must be generated on the fly from stored datasets interpreted by software protocols, there is an active coming into existence at the level of the pixel.[65]

In this sense we are dealing less than ever with stable, dependably addressable, losslessly reproducible image objects, but rather always only with distributed image processes. Their ›real time‹ is on one hand measured according to particular mathematical modelings of perceptual faculties—so-called perceptual coding[66]—but at the same time is offset with available infrastructures of transmission. It must first be noted that a fundamental assumption of operative aggregate states of the image is required here, of the image as process—or as »impulse sequence«[67]—in which is inscribed a media-technical blueprint, realized by means of algorithmic performances, which is adaptively aligned to the parameters of the signal transmission and is therefore primarily a transport plan: »[T]he image has to be considered as a kind of program, a process expressed *as, with, in* or *through* software. […] [C]onsidered computationally or algorithmically the image is […] operating in a constant state of deferral.«[68] In order for this deferring sense data unit ›image‹ to be created at all as an epistemic object, a certain heuristic immobilization of operative distribution processes is unavoidable in terms of terminology alone. At the same time, it is the case that the reference to microtemporalities, effects

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65 Cubitt, *The Practice of Light*, 251f.

66 Cf. Jonathan Sterne, *MP3: The Meaning of a Format*, Durham, NC: Duke University Press, 2012, 32–60.

67 »What flows in data streams, and here this means: what takes place in time and requires time, is the feeding of signals. It consists of a sequence of changes in the electrical field strength or, in fiber optic cables, luminosity. Transmitting a message does not last a certain time because a distance has to be overcome, but because the message signal occurs as a sequence of impulses« (Heidenreich, *FlipFlop*, 27).

68 Daniel Rubinstein, Katrina Sluis, »The Digital Image in Photographic Culture: Algorithmic Photography and the Crisis of Representation,« in: Martin Lister (ed.), *The Photographic Image in Digital Culture*, London: Routledge, 2013, 22–37, here: 29 (italics in the original).

of adaptation and coherence necessitates incorporating relational descriptive figures, or at least marking the relevant limits. Digital images fundamentally draw their distributed genealogy and phenomenality from a »channel that calculates with time.«[69]

What terminology is to be employed, how various terms relate to one another, and where systematic distinctions are useful, is a highly contentious topic of debate in media theory—primarily in critical studies of media infrastructures, in platform and software studies.[70] It is, however, widely agreed that a key term in this context is that of compression. Even at the level of agency, its modes of operation refer unambiguously to a distribution in which data centers appear as constitutively connected with network protocols, fiber optic cable routes with codec politics, infrastructures with interfaces, back-end with front-end technologies, broadband capacities with practices of use. Countless (human and non-human) actors are therefore involved in these media-technical distribution processes, in the »distributed character of culture in our age«[71]—actors that form the socio-technical ensembles by which persons, things, and signs are connected with one another and react to each other in a variety of constellations.

How the interdependencies that arise in this context can be understood conceptually is also dependent on epistemological interests. Cubitt, for instance, ultimately sees the digital image as a normalization tool within a comprehensive governmental regime of algorithmic temporal control, which therefore becomes hegemonic[72] above all through the predictive mechanisms of standardized MPEG codecs—or to be more precise: through

69 Wolfgang Ernst, »Medienwissen(schaft) zeitkritisch: Ein Programm aus der Sophienstraße,« inaugural lecture at Humboldt University, 21 Oct., 2003, https://edoc.hu-berlin.de/bitstream/handle/18452/2327/Ernst.pdf?sequence=1, here: 20.

70 For a complementary approach, which reacts above all to the circumstance that platform operators like Google have de facto taken over infrastructure functions (»infrastructuralized platforms«), aided by neoliberal agendas of deregulating and privatizing infrastructural sponsorship since the 1980s (»platformization of infrastructures«), see Paul N. Edwards, Carl Lagoze, Jean-Christophe Plantin, Christian Sandvig, »Infrastructure Studies meet Platform Studies in the Age of Google and Facebook,« *New Media & Society* (pre-publication version), Aug. 2016, https://doi.org/10.1177/1461444816661553.

71 Sterne, *MP3*, 1.

72 As the central position of the concept of contingency reveals, Cubitt draws on the following as an implicit blueprint: Mary Ann Doane, *The Emergence of Cinematic Time: Modernity, Contingency, the Archive*, Cambridge, MA: Harvard University Press, 2002.

complex algorithmic techniques like motion compensation.[73] His critique of compression algorithms—which at their core reduce transmission information by predicting this information (or its redundancy components) through calculation, interpolating and extrapolating it—seems to be at least partly grounded in remnants of a normative image aesthetics, insofar as one can only speak of »reducing quality« and of a »good-enough image«[74] against the backdrop of somehow better (or more beautiful) forms of visual existence.

A theoretical model linking data and the transmission channel more closely to one another comes from Jonathan Sterne. He also assumes a central significance for processes of algorithmic compression, but he bases this on a broader understanding of the dimension of transport that is productive in a different way. For Sterne compression is not an inferior process of reduced information quality, but a cultural technique encountered in various forms in all phases of media history that fundamentally allows for signals to be perceived across spatial distances because it relates communications to infrastructures differentially, enacting a situational filtering or screening of redundant information and thus creating the functional context of successful information exchange as such in the first place:

> [T]his means that media are not like suitcases; and images, sounds, and moving pictures are not like clothes. They have no existence apart from their containers and from their movements—or the possibility thereof. Compression makes infrastructures more valuable, capable of carrying or holding materials they otherwise would or could not, even as compression also transforms those materials to make them available to the infrastructure.[75]

The economization of signals—the codification of what is to be calculated at a particular point in the infrastructural capacity on the one hand as transmittable, on the other as lossy—serves to economically rationalize the channels against the backdrop of finite resources of transmission in information

73 Cf. Adrian Mackenzie, »Codecs,« in: Matthew Fuller (ed.), *Software Studies: A Lexicon*, Cambridge, MA: MIT Press, 2008, 48–54, here: 52f. More on this in chapter II.3 (Video Signal Histories).

74 Cubitt, *Practice of Light*, 256, 247. Cf. also Hito Steyerl, »In Defense of the Poor Image,« *e-flux journal* 10 (Nov. 2009), https://www.e-flux.com/journal/10/61362/in-defense-of-the-poor-image/.

75 Jonathan Sterne, »Compression. A Loose History,« in: Lisa Parks, Nicole Starosielski (eds.), *Signal Traffic: Critical Studies of Media Infrastructures*, Champaign: University of Illinois Press, 2015, 31–52, here: 36.

technologies, thus not least creating capacities for additional communications and increasing general mobility in the system. Because they would not be sent out on this journey in the first place as uncompressed or lossless (since they would be too bulky, too slow, too difficult to receive), the question of forms of packaging with different dimensions is secondary for Sterne, and consequently is replaced by a recursive model: »[C]ompression is the process that renders a mode of representation adequate to its infrastructures. But compression also renders the infrastructures adequate to representation.«[76] Compression therefore facilitates additional channel configurations through alternative signals, whose circulation in turn feeds back into infrastructural conditions with concrete evolutionary dynamics, with structures, standards, and formats that would not have existed in the same way without the historically specific realities of compression in each case—that is, also: without certain data remaining undistributed because they are calculated as redundant.[77]

From this perspective it becomes immediately clear that the distributed image does not arise from or run toward an immaterial ›flow‹ (especially under real-time conditions), but is modulated as a stream over a whole series of connected media operations and structures—no matter how immediate its phenomenal presence on end user devices may appear to be, no matter how effortlessly it can be managed, sent, and manipulated on social media. Ubiquity as well as fungibility therefore arise from modes of distribution that are highly versatile not only on the level of perception accessible to empirical users, but also with regard to their switchability through media technology. Distribution as outlined here is not something that happens to this image after the fact, as if from the outside, since it only exists as a transport commodity in motion, as a data packet that is structured accordingly and processes as well as communicates back structural givens; therefore, the variably scalable question of concrete container formats, codecs, and protocols, for instance, inevitably also implies the question of less visible levels of network architecture.

Where, when, and in what temporality and concentration images materialize in digital environments is more and more often fundamentally related to so-called content delivery networks (CDN), a central infrastructure component

76 Ibid., 35.

77 »We might simply call the reality relational. For instance, a single set of standards like those set by MPEG, the Moving Picture Experts Group, facilitated the circulation of video and audio recording on the Internet, but it also facilitated the development of new technologies of storage and transmission, like the video compact disc, satellite radio, and the DVD. Once again, it is not just communication adjusting to infrastructures, but infrastructures modified by phenomena of compression« (ibid., 47).

of contemporary data circulation that operates in the background even more efficiently than, for instance, data centers, whose energy footprints have meanwhile at least become the subject of public debates.[78] To put it simply, CDNs are proprietary distribution networks that reroute user requests via a request routing system on locally distributed replica servers in order to significantly optimize performance, especially for data-intensive and time-sensitive content with multimedia characteristics, on the basis of identified and geographically allocated IP addresses. Any market participant who distributes their streaming portfolio over market-dominating providers such as Akami or Amazon Web Services (AWS) brings the media server spatially closer to the edge of the network, to the client—thus reducing problems with latency times and volatile transmission rates.

The economic and strategic significance of CDNs is evident, for instance, in the fact that the streaming service Netflix no longer maintains any data centers of its own (and had no problem transferring its entire database—»everything that happens before you hit ›play‹«[79]—into the cloud of the AWS ecosystem[80] despite competing with Amazon Video), while at the same time insisting on distributing the 125 million hours of video playback per day currently being requested by customers exclusively via Open Connect, their in-house CDN. The provider's complex strategy of content delivery differs in specifics from region to region, but is fundamentally based on the principle of local Open Connect boxes (around a thousand worldwide at present), which are utilized during off-peak times with copies of the contents most likely to be requested regionally but otherwise attempt to minimize intercontinental traffic.[81]

78 Cf. for instance James Glanz, »Power, Pollution and the Internet,« *New York Times*, Sept. 23, 2012, and Nicole Starosielski, Janet Walker (eds.), *Sustainable Media: Critical Approaches to Media and Environment*, New York: Routledge, 2016.

79 Ken Florance, »How Netflix Works With ISPs Around the Globe to Deliver a Great Viewing Experience,« *Netflix Newsroom*, March 17, 2016, https://about.netflix.com/en/news/how-netflix-works-with-isps-around-the-globe-to-deliver-a-great-viewing-experience.

80 Cf. Peter Judge, »Netflix's Data Centers are Dead, Long Live the CDN!« *DatacenterDynamics*, August 20, 2015, https://www.datacenterdynamics.com/en/opinions/netflixs-data-centers-are-dead-long-live-the-cdn/.

81 Indeed, to protect the Internet from collapse: »These so-called Open Connect appliances serve a simple purpose: To keep Netflix from clogging up the Internet. In North America alone, Netflix is singlehandedly responsible for 37 percent of downstream Internet traffic during peak hours. The service as a whole streams 125 million hours of content every single day. Without relieving as many pressure points as possible, things could get ugly, fast. The total capacity of the Internet's country-to-country backbone is 35TB per second, says Ken Florance, Netflix's VP of content delivery. ›Our peak traffic is more than that … Our scale is actually larger than the international capacity of the Internet.‹ Netflix doesn't literally break the Internet because the vast majority of its traffic is delivered locally, via

Data material from providers that forgo the service of CDNs does continue to circulate, but in a somewhat second-rate, comparatively slow orbit. CDNs produce and market distribution hierarchies. They differentiate the stream of images according to ranges of circulation and graded signal transit times. Regardless of any final decisions about net neutrality, there have long been reservable fast tracks and express delivery options at this level, a differentiation of data circuits that manifests as variable mobility and stability in content delivery. Thus there are various flows depending on which infrastructures operationalize them.[82] The logistical resources invested are therefore translated directly into the calculations of today's economy of visual culture. Whatever can be distributed more quickly optimizes accessibility, accumulates visibility. What is clearly less transparent are the structural requirements of this redistribution of attention: »Unlike a public standard built into the protocols of the Internet, Akami is a proprietary system that acts as an overlay, an invisible network concealed inside the network.«[83]

In this context Christian Sandvig has shown how the massive demand for audiovisual content has led to reorganizing network architecture that was not initially oriented toward such a purpose. Compression technologies that aim first to reduce data traffic and second to direct it only under constant observation of transmission capacity—that is, adaptively—form a hybrid streaming system on the basis of CDNs, which in a certain respect aligns the Internet as a distribution structure with that medium whose format history on the content surface is already being constantly re-mediatized: television.

Open Connect, rather than across the transoceanic cables that connect the Internet between continents« (Brian Barrett, »Netflix's Grand, Daring, maybe Crazy Plan to Conquer the World,« *WIRED*, March 27, 2016, https://www.wired.com/2016/03/netflixs-grand-maybe-crazy-plan-conquer-world/). A more detailed examination of the traffic footprint of streaming servers can be found in Tim Boettger, Felix Cuadrado, Gareth Tyson, »Open Connect Everywhere: A Glimpse at the Internet Ecosystem through the Lens of the Netflix CDN,« *ACM SIGCOMM Comput. Commun. Rev.* 48/1 (Jan. 2018), 28–34, https://doi.org/10.1145/3211852.3211857. On the »integrative« logistical role of data centers and their »operative mobility,« see also Rossiter, *Software, Infrastructure, Labor*, 138–181.

82 In the long term, this can lead to the fragmentation of the Internet as a »globally consistent address space,« as Geoff Huston has argued: »We are seeing the waning use of a model that invests predominantly in carriage, such that the user is ›transported‹ to the door of the content bunker. In its place we are using a model that pushes a copy of the content towards the user, bypassing much of the previous carriage function. […] But this model also raises some interesting questions about the coherence of the Internet. […] [W]e are seeing some degree of segmentation, or fragmentation, in the architecture of the Internet as a result of the service delivery specialization« (Geoff Huston, »The Death of Transit?« *APNIC Blog*, Oct. 28, 2016, https://blog.apnic.net/2016/10/28/the-death-of-transit/).

83 Sandvig, »Internet as Anti-Television,« 234.

Because mass media content such as the series format, which was initially shaped by television, has been successfully transferred to the Internet and remains in demand,[84] because in addition many consumers want to call up popular content at more or less the same time, just as before, and, contrary to the empowerment utopia of ›prosumers‹ ostensibly engaged in constant broadcasting, the asymmetry between downstream and upstream has remained in place—it became problematic that the network architecture, in contrast to radio broadcasting, generates additional transmission costs for each additional consumer. Since multicast systems do increase efficiency but have thus far been unable to satisfy the obvious demand for broadcasting content by distributing information on a mass scale, a development arose that Sandvig quite convincingly characterizes as media-historical »retrofitting«:

> As the Internet evolved, a remaining technical challenge was adapting its point-to-point architecture to the one-to-many asymmetries of audiences and attention. [...] Recent empirical studies of Internet traffic [revealed] that the network has reached an inflection point, where the Internet is now, for the first time, centrally organized around serving video. And this does not refer to video as a mode of communication in general, but specifically to serving a particular kind of video from a very small number of providers to large numbers of consumers. [...] During peak video watching times, two providers (Netflix and YouTube) account for more than half of all Internet traffic in North America.[85]

Internet infrastructure analysts such as Joon Ian Wong therefore maintain the thesis that the unbridled growth in video stream volume—the distribution of video data accounted for around 70% of all Internet traffic in 2018 (Cisco assumes that this will increase to 82% in 2021[86])—is the catalyst and the driving force behind an extensive restructuring of Internet architecture, which is becoming more and more »flat,« privatized, centralized, since corporations such as Alphabet/Google (especially after the company acquired the video

84 Cf. John T. Caldwell, »Convergence Television: Aggregating Form and Repurposing Content in the Culture of Conglomeration,« in: Lynn Spigel, Jan Olsson (eds.), *Television After TV*, Durham, NC: Duke University Press, 2004, 41–72; Ghislain Thibault, »Streaming: A Media Hydrography of Televisual Flows,« *Journal of European Television History & Culture* 4/7 (2015), 110–119; and Simon Rothöhler, »Content in Serie,« *Merkur. Deutsche Zeitschrift für europäisches Denken* 778 (March 2014), 231–235.

85 Sandvig, »Internet as Anti-Television,« 233, 237.

86 Cf. Cisco Public, *The Zettabyte Era: Trends and Analysis* (white paper), Cisco VNI, June 07, 2017.

platform YouTube in 2006), Facebook, and Netflix began investing heavily in CDN infrastructures.[87]

The general tendency toward centralization—the global dominance of a small, fundamentally oligopolistic group of vertically integrated media corporations[88]—is not only reflected at almost all infrastructural levels and in the prehistories of communications economics,[89] but can also be seen in the implementation of a non-proprietary standard such as JPEG (Joint Photographic Experts Group). As an image compression norm that profoundly reorganizes the raw data of digital image acquisition (stored for instance as RAW files or so-called digital negatives), in part through processes of color space conversion and quantification, this format effectively represents a kind of gatekeeper, codifying what is at all communicable, conveyable, distributable in an image. Paul Caplan succinctly describes how a standard asserts itself in quite ordinary practices of social media image distribution:

87 »It's a fundamental change to the way data has been routed over the internet for decades, which was classically conceived of as a tiered hierarchy of internet providers, with about a dozen large networks comprising the ›backbone‹ of the internet. The internet today is no longer tiered; instead, the experts who measure the global network have a new description for what's going on: it's the flattening of the internet. […] As video flows through increasingly vertically integrated networks, technologies that hew to the net's principles of decentralization are getting left behind. It's a simple function of supply and demand—video piped directly from Amazon or Netflix to a consumer ISP is simply a better experience« (Joon Ian Wong, »The Internet Has Been Quietly Rewired, and Video Is the Reason Why,« *Quartz*, Oct. 5, 2016, https://qz.com/742474/how-streaming-video-changed-the-shape-of-the-internet/).

88 The *Wired* author Bruce Sterling popularized the term »stacks« to describe the »Big Five« in terms of industrial policy (Alphabet, Amazon, Apple, Facebook, Microsoft; for an expanded understanding of the term as a »megastructure« of ubiquitous computation, see Benjamin Bratton, *The Stack: On Software and Sovereignty*, Cambridge, MA: MIT Press, 2015). Another central player in the allocation of global data traffic volume is the pornography monopolist MindGeek (previously Manwin), whose video aggregators (including Pornhub, YouPorn, RedTube) together claim more bandwidth than Amazon or Facebook (cf. Shira Tarrant, *The Pornography Industry*, Oxford: Oxford University Press, 2016; Joe Pinker, »The Hidden Economics of Porn,« *The Atlantic*, April 4, 2016, https://www.theatlantic.com/business/archive/2016/04/pornography-industry-economics-tarrant/476580/; Katrina Forrester, »Lights. Camera. Action: Making Sense of Modern Pornography,« *The New Yorker*, Sept. 26, 2016; David Auerbach, »Vampire Porn,« *Slate*, Oct. 23, 2014, https://slate.com/technology/2014/10/mindgeek-porn-monopoly-its-dominance-is-a-cautionary-tale-for-other-industries.html).

89 Cf. Nicole Starosielski, *The Undersea Network*, Durham, NC: Duke University Press, 2015.

> In the dialog box that opened, I could see the files on my computer. JPEG-encoded and PNG-encoded files were visible. Their names were black. I could select them, add them to the waiting list and upload them to my account/Timeline/profile, tag them and make them part of the government of (my)self on the Open Graph. The RAW-encoded and WebP-encoded objects however are ›greyed out‹—a symbolic lesser status. They fade into the background. Inaccessible. Unvisible. They are locked out, unavailable for networking, tagging, recognising, data-mining, integrating into and exploiting (or being exploited by) the power of the Open Graph. My imaging was about encoding and then sharing and connecting light-as-data through standards. When I built that apparatus with JPEG, it worked fine. Light became social data. When I didn't ... it didn't. Light became unsocial data.[90]

Standards like JPEG stipulate how data must be packaged and aggregated in order to be distributable. They generate connectivity as well as controllability, defining well into the infra-imaging parameters which configurations of visual culture can be formulated: »The code works to reorganize relations within and between images.«[91] The exclusion effects typical of such deeply intervening distinguishing authorities (legible/illegible, distributable/indistributable) identify a further arena in which negotiations—framed »expertocratically« in the case of JPEG and MPEG[92]—are held concerning the format conditions under which an (audio)visual signal is taken up by the transport channels, how an image becomes an element of the general bitrate stream, what relationships between images are possible, and how the constellations that arise relate to economic calculations. This once again reveals the profusion of preconditions inherent in the processual character of contemporary imaging, which is not limited to an immaterial softwarization of the entirety of cultural material,[93] but rather calls up infrastructural input and distributes the configuration of actors involved at every operative step.

90 Paul Caplan, *JPEG: The Quadruple Object*, PhD thesis, Birkbeck, University of London, 2014, 174.

91 Mackenzie, »Codecs,« 50.

92 Jonathan Sterne has more closely examined the regulative process of »standard-making« using the example of the Moving Pictures Experts Group (MPEG) established in 1988: Sterne, *MP3*, 128–147.

93 This is essentially the idea in: Manovich, *Software Takes Command*.

This simultaneously outlines a spectrum of digital materiality[94] that, as Caplan suggests, illuminates a whole series of interdependencies—even beyond »forensically«[95] examined processors, hard drives, and displays—which connect a standard like JPEG with factory work and a raw material like oil.[96] Furthermore, while dominant discursive figures such as ›ubiquity,‹ ›real time,‹ ›wirelessness,‹ ›cloud,‹ tend to postulate a network-based distribution of ›pure information‹ as a communicative state of connectivity that has always existed and has by now become practically natural, more recent studies such as Tung-Hui Hu's *A Prehistory of the Cloud*[97] or Nicole Starosielski's *The Undersea Network* point to the historical processes of forming the socio-technical substructure, which, in the latter case, can be traced back to the colonial history of telegraph cable stations. Against the dominant cultural imaginary that sees the circulation of immaterial signs as a directly established reality of digital distribution, what we see now are path dependencies and conflict histories, the intertwining of practices and technologies, but also more generally the costs of energy, work, and raw materials,[98] which are theoretically proportionately convertible to each individual data packet transmission, that is, scaling

94 Cf. Paul Dourish, *The Stuff of Bits: An Essay on the Materialities of Information*, Cambridge, MA: MIT Press, 2017; and Jean-François Blanchette, »A Material History of Bits,« *Journal of the American Society for Information Science and Technology* 62/6 (2011), 1042–1057. On staking out the discursive field in media studies, cf. Ramón Reichert, Annika Richterich, »Introduction. Digital Materialism,« *Digital Culture and Society* 1/1 (2015), 5–18, https://doi.org/10.14361/dcs-2015-0102; and Jussi Parikka, *A Geology of Media*, Minneapolis: University of Minnesota Press, 2015, 1–29.

95 Matthew G. Kirschenbaum, *Mechanisms: New Media and the Forensic Imagination*, Cambridge, MA: MIT Press, 2008.

96 »JPEG photography is a complex ecology of human and unhuman objects connecting the photographer, the camera, the silicon and battery, the factories and poisoned workers, the card and the router, Web 2.0 businesses, servers and the power that runs them, the carbon burnt to keep those searchable archives running, the ›friend‹ and searcher, the IP lawyer and countless other actants. This project is about those objects and the complex, inaccessible relations and connections that make up digital imag(in)ing« (Caplan, *JPEG*, 11). See also Trebor Scholz (ed.), *Digital Labor: The Internet as Playground and Factory*, New York: Routledge, 2013; and Rossiter, *Software, Infrastructure, Labor*.

97 Tung-Hui Hu, *A Prehistory of the Cloud*, Cambridge, MA: MIT Press, 2015.

98 Cf. Jussi Parikka (ed.), *Medianatures: The Materiality of Information Technology and Electronic Waste*, Open Humanities Press, 2011, http://www.livingbooksaboutlife.org/books/Medianatures; Christian Fuchs, *Digital Labour and Karl Marx*, New York: Routledge, 2014; Babette B. Tischleder, Sarah Wasserman (eds.), *Cultures of Obsolescence: History, Materiality, and the Digital Age*, Basingstoke, UK: Palgrave Macmillan, 2015.

consumption rates and weights of datagrams that result from the transport cost itself.[99]

Recent growth spurts in distributed data volume correlate to a fundamentally observable temporal transformation of the Internet, in which streaming has in a certain sense been generalized as a form of transmission and experience beyond the question of standardized transport protocols and concrete modes of integrating audiovisual signals. More and more addresses no longer lead to static websites, but to data streams that are automatically updated in real time. Connections are established to be maintained for an unspecified time. Data packet transfer increasingly seems to be arranged as an open-ended series that can end, but does not have to from the point of view of the server. This gives rise to a permanent contemporaneity in data exchange, which refers neither to final data sets nor to concluded futures of transmission—which is why horizons of expectation arise in terms of media temporality, which David Berry, borrowing from Jacques Derrida, has called »messianic.«[100]

Viewed empirically, most streams begin and end at some point—but in information-technological terms they are designed to be continuous.[101] Transmission thus always only relates to temporary states of data, to the present time of an ever-filling data pool, to filters that can be operated variably, generating and processing a corresponding aggregation. This development,

99 Cf. Joel Combiner, »Carbon Footprinting the Internet,« *Consilience: The Journal of Sustainable Development* 5/1 (2011), 119–124. The rapidly growing, volume-intensive proliferation of audiovisual traffic has also had an effect on the expansion of the transoceanic undersea cable network while, for instance, satellite technology has fallen behind, as Nicole Starosielski has shown: »Over the past twenty years, satellites' capacity has filled up, and conditions have shifted significantly to favor fiber-optic cables. Cables are now able to carry a greater amount of information at faster speeds and at lower cost than satellites (a signal traveling between New York and London takes about one-eighth the time to reach its destination by cable as it does by satellite). With the emergence of high-definition video and high-bandwidth content on the Internet (a shift that favors cable infrastructure), the disparity between the two looks like it will increase. Despite the rhetoric of wirelessness, we exist in a world that is more wired than ever« (Starosielski, *Undersea Network*, 9).

100 David M. Berry, »Messianic Media: Notes on the Real-time Stream,« *Stunlaw* (blog), Sept. 12, 2011, http://stunlaw.blogspot.com/2011/09/messianic-media-notes-on-real-time.html.

101 »As opposed to previous mechanisms that work on opening and closing server connections, and pulling in information on request, this new type of data processing performs a continuous query for new data units that arrive in the database and pushes the result into the stream according to the filter being used. The result is thus a persistent, real-time connection between a server and a user« (Nadav Hochman, »The Social Media Image,« *Big Data & Society*, July-Dec. 2014, 1–15, here: 2).

whose beginning has repeatedly been linked to the advent of RSS feeds[102] but then expanded further through push technologies, is now considered a fundamental principle of the general streaming quality of data traffic, especially due to the dominant architecture and addressing modes used by popular platforms with social media characteristics.[103]

The underlying model of real-time processing replaces one-time data bank requests with continuous queries,[104] and is articulated on the surface primarily through responsive interfaces with the option of real-time interaction (or with a prompt for it: »What's happening?« asks Twitter, »What's on your mind?« asks Facebook). The continuous, dynamic implementation of data streams flowing in and out reaches the user in the form of a mediated ›nowness,‹ which may be programmed differently in terms of the media's time-critical operational logic (how is the live feed synchronized, how is the newest content integrated into the timeline in each case, how are the interaction modes operated, etc.[105]), but in the final analysis mainly either generates synchronization effects, or transmits them in a way that »habitualizes,« as Wendy Chun suggests.[106]

102 Cf. John Borthwick, »Distribution … Now,« *THINK/Musings* (blog), May 13, 2009, http://www.borthwick.com/weblog/2009/05/13/699/.

103 »The way we have traditionally thought about the Internet has been in terms of pages, but we see this changing to the concept of ›streams.‹ In essence, the change represents a move from a notion of information retrieval, where a user would attend a particular machine to extract data as and when it was required, to an ecology of data streams that form intensive information environments. […] Importantly, the real-time stream is not just an empirical object; it also serves as a technological imaginary. […] In the world of the real-time stream, it is argued that the user will be constantly bombarded with data from a thousand (million) different places, all in real-time, and that without the complementary technology to manage and comprehend the data she would drown in information overload. But importantly, the user will also increasingly desire the real-time stream, both to be in it, to follow it, and to participate in it« (David M. Berry, »Real-Time Streams and the @Cloud,« *Stunlaw* (blog), Jan. 13, 2011, http://stunlaw.blogspot.com/2011/01/real-time-streams-and-cloud.html); see also Lev Manovich, »Data Stream, Database, Timeline,« *Software Studies Initiative* (blog), Oct. 27, 2012, http://lab.softwarestudies.com/2012/10/data-stream-database-timeline-new.html.

104 Cf. Minos Garofalakis, Johannes Gehrke, Rajeev Rastogi, »Data Stream Management. A Brave New World,« in: *Data Stream Management: Processing High-Speed Data Streams*, New York: Springer, 2016, 1–13.

105 Real-time is therefore not only conveyed through media technology, that is, produced by it, but can also be flexibly modulated and fine-tuned by it—there are various (e.g., platform-specific) forms of »realtimeness« (see Esther Weltevrede, Anne Helmond, Carolin Gerlitz, »The Politics of Real-Time: A Device Perspective on Social Media Platforms and Search Engines,« *Theory, Culture & Society* 31/6 (2014), 125–150).

106 Cf. Chun, *Updating to Remain the Same*.

Phenomena such as dynamically updating platforms, predictive search engine algorithms—which not only switch to autocomplete while search terms are being entered, but like Google Instant immediately start to produce queries and results—as well as the by now completely commonplace real-time integration and implementation of user-generated content, accordingly produce an ›environmental‹ model of data traffic, which seems to consist of continuously maintained data circuits, of data streams that swell and ebb according to filter and newsfeed flow timing: »The transfer of data beyond their contents becomes the permanent condition of our surroundings.«[107] Users may have access to certain platform-specific options, ways of entering into and exiting out of the stream at the interface level, or its appearance during the interaction. Independent of this, however, streaming has become a regulatory principle of distributed data volume. It is no longer only of interest to privileged financial service providers and their real-time monitoring of market activity,[108] nor does it first and foremost pertain to an efficient form of transmitting volume-intensive audiovisual signals. Instead, it characterizes our general relation to digital data traffic under the conditions of permanent connectivity and ambient computation.[109]

Image data, too, therefore are no longer shielded as they flow out of relatively static architectures, but are interwoven with other automatically updated stream data, which are subject to the specific agendas of datafication, of »real-time analytics.«[110] Clearly, this distribution model does not generate stable, permanently fixable arrangements. All data here tend to be distributed data—data in which a temporal relation is inscribed, independent of the modes of their processing. The ›nowness‹ signals are put on a trajectory, made transportable to future states of nowness. The data stream, framed as both infrastructurally and materially complex, therefore allows only for snapshots, contingent cuts through fluid periods of data. On the outer surface, tentative status reports emerge that are perceptible for human actors and arise from

107 Christoph Engemann, Florian Sprenger, »Im Netz der Dinge. Zur Einleitung,« in: Engemann, Sprenger (eds.), *Das Internet der Dinge. Über smarte Objekte, intelligente Umgebungen und die technische Durchdringung der Welt*, Bielefeld: Transcript, 2015, 7–58, here: 28.

108 On high-frequency trading (HFT) cf. Matthew Tiessen, »High-Frequency Trading and the Centering of the (Financial) Periphery,« *Volume* #32, Sept. 09, 2012, http://volumeproject.org/high-frequency-trading-and-the-centering-of-the-financial-periphery/.

109 More on this in Part III.

110 Cf. Byron Ellis, *Real-Time Analytics: Techniques to Analyze and Visualize Streaming Data*, New York: Wiley, 2014.

flow samples, gathered for purposes of visualization, which are barely transmitted before being discarded again, attracted by new futures. Aggregation means: data are specifically accumulated on demand and organized intently for the purpose of representation. ›Real time‹ in this regard means that the presumed nanoseconds of computation and transmission do not make a perceivable difference at the front end, or, if so, then only as a glitch[111] or in the sense of subliminal update rhythms, which arise from the user addressing of platforms and search engines that are finely nuanced temporally and their »distinctive real-time cultures.«[112] At the level of these microtemporal intervals the operationalized »chronologistics« is not implemented in real time, but reactively: as switching and computing time it is synchronized according to models of »timeliness.«[113]

The image data are in motion, even if they are not directly mobilized graphically. Stream phenomena are—regardless of the temporality of their perceptually coded playback, as in the case of video data—defined in terms of the time-critical processes of their computation and distribution. The decisive question is therefore not (any longer) what an image is, but when, where, and how image data can be enunciated as an image: »[T]here is an endless succession of temporary constellations of images held together by a certain correlation of metadata, distribution of pixels or Boolean query [...]. There is a shift here away from content to the rhythm, circulation, and proliferation of the utterance.«[114] What is distributed are the media-technical infrastructures and processes of enunciation, but also phenomenalities, contexts, coverages, connectivities, and efficacies of those transmitted datagram series that can be iconically implemented and perceptible as (still or moving) image. In the context of a variably configured, but constantly connected streaming traffic that processes and transfers information in a semantically neutral way,[115] every

111 Cf. Peter Krapp, *Noise Channels: Glitch and Error in Digital Culture*, Minneapolis: University of Minnesota Press, 2009; and Rosa Menkan, *The Glitch Moment*(*um*), Amsterdam: INC, 2011.

112 Weltevrede, Helmond, Gerlitz, »The Politics of Real-Time,« 137.

113 Axel Volmar, »Zeitkritische Medien im Kontext von Wahrnehmung, Kommunikation und Ästhetik. Eine Einleitung,« in: Volmar (ed.), *Zeitkritische Medien*, Berlin: Kadmos, 2009, 9–26, here: 10. See also Julian Rohrhuber, »Das Rechtzeitige. Doppelte Extension und formales Experiment,« in: ibid., 195–212.

114 Rubinstein, Sluis, »The Digital Image,« 30f.

115 »Protocols are highly formal; that is, they encapsulate information inside a technically defined wrapper, while remaining relatively indifferent to the content of information contained within« (Alexander R. Galloway, *Protocol: How Control Exists after Decentralization*, Cambridge, MA: MIT Press, 2006, 7f.).

form of distributed imagery is surrounded by data material—and is itself data material. The next chapter will examine in more detail the differences that various data dimensions make, and to what extent the bitmap stream is a repeatedly datafied traffic volume, before we turn to the question of how stream and memory relate to one another.

I.2 Datafying

The datafication[116] of digital images leads to consequential modifications on various levels, but it initially does not change the fact that these images cannot always be clearly distinguished from analog images. Categorically speaking, not at all—the transitions are entirely seamless, above all with regard to praxeology.[117] Even the prehistories of discretization in image technology have deep roots.[118] To the extent that digital images exist in binary codes and can be computed as ›pictorial bits,‹ so to speak, they are in fact subordinate to novel registers of informational operativity. For the discourses of crisis in media studies that were variously introduced during the 1990s, the digital image was therefore considered a collection of unreliable pixels.[119] There was widespread concern about the fact that the relation between image file and image display could not readily be translated back into established ideas of ›analog‹ connectivity and continuity: »Within a coded environment, forms of appearance are optional.«[120] Consequently there was a data relation inherent in the algorithmic addressability of this image that not only caused trouble in the »submedial space,«[121] but transformed entire visual surfaces into discretely manipulable elements and process calculations. In the relevant critical discussions about the digital image, datafication first became ontologically one-sided, then unilaterally suspect.

Nevertheless, the assumption that we are dealing with a data image that is contingent with respect to its concrete appearance, that must always be understood as the product of multiple »translations«[122] and taking into

116 »To datafy a phenomenon is to put it in a quantified format so it can be tabulated and analysed« (Viktor Mayer-Schönberger, Kenneth Cukier, *Big Data: A Revolution That Will Transform How We Live, Work and Think*, London: John Murray, 2013, 78).

117 Cf. Ritchin, *After Photography*; and Martin Lister (ed.), *The Photographic Image in Digital Culture* (Second Edition), London: Routledge, 2013.

118 Cf. Part II.

119 Cf. Peter Lunefeld, »Digitale Fotografie. Das dubitative Bild,« in: Hertha Wolf (ed.), *Paradigma Fotografie. Fotokritik am Ende des fotografischen Zeitalters*, Frankfurt/Main: Suhrkamp, 2003, 158–177. For a discourse-historical overview, cf. Bernd Stiegler, *Theoriegeschichte der Fotografie*, Paderborn: Fink, 2003, 407ff.; and Philippe Dubois, *Der fotografische Akt. Versuch über ein theoretisches Dispositiv*, Hamburg: Philo Fine Art, 1998.

120 Eivind Røssaak, »Algorithmic Culture: Beyond the Photo/Film Divide,« in: Røssaak (ed.), *Between Stillness and Motion: Film, Photography, Algorithms*, Amsterdam: Amsterdam University Press, 2011, 187–206, here: 191.

121 Boris Groys, *Unter Verdacht. Eine Phänomenologie der Medien*, Munich: Hanser, 2000.

122 Till Heilmann gets to the heart of this in relation to the digital computer: »In its translatability it is […] clear how problematic the question of what digitally coded information

account its media-technical distributedness, is in principle coherent from today's perspective—although it still requires differentiation. What is initially utterly striking when looking back at the history of this discourse, which is not pursued further here, is first of all that for a long time the topic of discussion was almost exclusively the datafication of image acquisition and manipulation. The distributional implications of those »computer graphics«[123] that now dominate the field of technological imagery, whose photographic qualities and effects often could not be denied, despite expanded options for intervening through software technology, played practically no role at all. In this narrow perspective, the fact that the pixel values distributed in raster graphics[124] were data of a new kind (and enabled novel visual practices) resulted primarily from the digital mode of storing light. Instead of mobilizing silver salt crystals within an emulsion layer, there now emerged—after the transformation of an analog measuring signal into the digital value of a whole number[125]—a binary movement of zeros and ones, which took on the data form of a very long, very

›actually‹ represents is. Bits as bits, that is, as elements of formal materiality, do not belong to the order of the sensorily perceptible, and after their translating switchings, must first be transformed for human eyes and ears (or other senses)—an operation that itself represents a translation. […] Digitally coded information can never appear ›in itself,‹ ›as such,‹ or as ›itself,‹ but always only in translation. This is not the expression of a ›truth‹ immanent to the data. […] The non-trivial moment of computerized translatability of data consists in the fact that digitally coded information knows an irreducible multitude of representations, none of which can be identified as the ›correct‹ or ›authentic‹ one. […] [This also applies to a] JPEG file. When working at a computer it probably first appears to the user as a list entry in a directory window, with its name, size, type, and various timestamps. It may also appear as a graphic icon or as a miniaturized preview in an image management program. Perhaps the user is only interested in metadata embedded in the file that describe the exact circumstances of the image capture by a digital camera. Image processing programs can also display the file as a histogram, which visualizes the tonal value distribution. Of course, one can enlarge details in the image representation so that a small section fills the whole monitor. And in special cases, information hidden in the file steganographically (e.g., the source code of DeCSS) can be made visible. For the majority of users, the full-screen display of a JPEG may look like its ›actual‹ representation; but it is only one of several possible translations« (Till A. Heilmann, »Digitale Kodierung und Repräsentation. DVD, CSS und DeCSS«, *Navigationen* 2 (2010), 95–112, here: 109f.).

123 Friedrich Kittler, »Computergrafik. Eine halbtechnische Einführung,« in: Hertha Wolf (ed.), *Paradigma Fotografie. Fotokritik am Ende des fotografischen Zeitalters*, Frankfurt/Main: Suhrkamp, 2003, 178–194.

124 Cf. Graham Harwood, »Pixel,« in: Matthew Fuller (ed.), *Software Studies. A Lexicon*, Cambridge, MA: MIT Press, 2008, 213–217.

125 Strictly speaking, this A/D conversion process is an operation in which voltage ranges are assigned numerical values that actually describe value ranges (cf. Kathrin Passig, Aleks Scholz, »Schlamm und Brei und Bits. Warum es die Digitalisierung nicht gibt,« *Merkur. Deutsche Zeitschrift für europäisches Denken* 798 (Nov. 2015), 75–81).

abstract series of numbers. This ›telephone number‹—or its translation as locally coded values of brightness and color within a two-dimensional bitmap raster—would now have to be dealt with by anyone wishing to attain iconic connections.[126] But what can be said about the datafication of digital images if we assume the calculations of their distribution through information technologies? What datafication dynamics of the distributed image are of a genuinely logistical origin, insofar as they are connected with transport calculations?

Countless recent visual phenomena owe their existence to an immediate calculation of collected data pools. For instance, digital processes of image acquisition are usually bound, already ›within‹ the camera, to manipulation processes that can be programmed in different ways. Datafication here first and foremost means: instantaneous processing.[127] A typical example of corresponding real-time conversions (that is, without perceivable ›development time‹) would be a process like so-called image stitching, in which—through the triad of image alignment, warping, and blending—panoramic images that can be transported directly to displays are generated from several individual shots through algorithmic ›stitching.‹[128] But as Paul Caplan and Daniel Palmer have shown, digital image processing actually already begins before such editing achievements: in the photon-electron conversion and those automatic memory processes that then no longer write the image information as voltage, but as binary coded data according to standardized format algorithms.[129]

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126 The details of the participating processes of transformation, quantification, and discretization are extensively traced by Paul Caplan from the perspective of the JPEG—he summarizes: »Having started as light photons, being turned into electrical charge and from there into data, the resultant information has been sorted and compressed by JPEG into a file ready to be written (potentially alongside a RAW file) to the camera's memory« (Caplan, *JPEG*, 21).

127 For an alternative understanding of the term from the context of empirical research on the impacts of media, cf. Isabel Otto, »Verdatung/Medienwirkung,« in: Christina Barz, Ludwig Jäger, Marcus Krause, Erika Linz (eds.), *Handbuch der Mediologie. Signaturen des Medialen*, Paderborn: Fink, 2012, 316–321.

128 Cf. Simon Rothöhler, »Die zwölfte Fläche. Streaming, Mapping, Stitching Places: Zu ›Haiti 360°‹ und ›People's Park‹,« in: *Zeitschrift für Medienwissenschaft*, 11 (2014), 102–112. Inge Hinterwaldner—with regard to burst photography, in which up to 240 exposures per second can be achieved—has suggested the term »summation image« here (Inge Hinterwaldner, »Das Einwegbild. Fünf Überlegungen zu einem Bildtypus, der (nicht) existiert,« in: Hinterwaldner, Michael Hagner, Vera Wolff (eds.), *Einwegbilder*, Paderborn: Fink, 2016, 9–15, here: 10).

129 Caplan calls this multi-step process »digital imaging pipeline« (cf. Caplan, *JPEG*, 16ff.); Palmer examines the role of CCD microchips within the »computational logic of photography« (Daniel Palmer, »The Rhetoric of the JPEG,« in: Martin Lister (ed.),

The dimension of memory mentioned here—as well as its relationship to the streaming nature of current image data traffic—will be examined more fully in the next chapter, and datafication as transcoding and retro-digitization with regard to archival photographs will be the topic of chapter II.2. But what needs to be considered at this point is that the mobility and formability of the distributed data image is on various levels bound to transport-related processes of storing and leaving traces. A media technology that is more than just marginally involved in these processes transfers the data, organized and labelled in tabular form, into those banks that Martin Warnke has called the »citadels in the Web 2.0.«[130] If digital data are always already »cooked«[131] and already »structured«[132] with regard to algorithmic access, this also raises the question of how they are collected and kept available for queries. In other words: what computational operations can be carried out with an image data set—a data set that can take on the conventional appearance ›image‹—how it can be connected and transferred, is also defined on the one hand by its format, and on the other by the form of its storage. Datafication therefore as a rule also means: a situating incorporation into a data bank architecture.

If in this regard we follow Marcus Burckhardt's theory of digital data banks, which emphasizes the role of data bank management systems (DBMS) as generative collection technologies and fundamentally rejects the idea of passive memory, at this level as well we can see a technological infrastructure of digital imagery that does not so much collect static objects as it manages dynamic processes. Instead of reproducing previously established hierarchies, »the data bank represents the potential to make it possible to arrange or experience the same information in a variety of ways on the user interface, and in doing so to give it different meanings.«[133] Anything that is stored in a certain way, in a specific form, with a unique address, can be visualized, transported, communicatively mobilized in various ways. In this sense, we do not simply access stored information—rather, it is actualized, that is, generated anew. Precisely how the data are secured in the »deep structure« of a data bank is thus independent

The Photographic Image in Digital Culture (Second Edition), London: Routledge, 2013, 149–164).

130 Martin Warnke, »Datenbanken als Zitadellen im Web 2.0,« in: Stefan Böhme, Rolf F. Nohr, Serjoscha Wiemer (eds.), *Sortieren, Sammeln, Suchen. Die Datenbank als mediale Praxis*, Münster: LIT Verlag, 2012, 123–136.

131 Cf. Lisa Gitelman, Virginia Jackson, »Introduction,« in: Lisa Gitelman (ed.), *»Raw Data« is an Oxymoron*, Cambridge, MA: MIT Press, 2013, 1–14.

132 Lev Manovich understands bitmaps in this sense as »data structures« (Manovich, *Software Takes Command*, 209ff.).

133 Marcus Burckhardt, *Digitale Datenbanken. Eine Medientheorie im Zeitalter von Big Data*, Bielefeld: Transcript, 2015, 142.

of the »level of expression,«[134] insofar as data bank architectures (as well as compression algorithms) are typical cases of »blackboxing.«[135] Their power of definition is manifest in inclusions and exclusions of particular data sets, in communicating compatibility. The usefulness of data is unrelated to any understanding of its technological condition and organization on the part of the user. Such nontransparency in no way detracts from the efficacy of a data bank. The user must pragmatically recognize the compatibility settings, but need not understand the logic of storage, the data room, in order to be able to initiate productive queries, whose capacity for connection causes manifestations as well as meanings to be redistributed. In the context of Lisa Gitelman's definition of the term ›data‹—according to which data are discretely and aggregatively, abstractly and graphically mobilizable—this situation is presented as follows:

> Today the ubiquitous structures of data aggregation are computational forms called relational databases. Described and developed since 1970, relational databases organize data into separate stables (›relational variables‹) in such a way that new data and new kinds of data can be added or subtracted without making earlier arrangements obsolete. Data are effectively made independent of their organization, and users who perform logical operations on the data are thus ›protected‹ from having to know how the data is organized.[136]

This »selective protection of knowledge«[137] also determines, as David Gugerli has explained, what is required for data to be searchable, how they can be

134 Cf. ibid., 146.

135 Cf. Bruno Latour, *Pandora's Hope: Essays on the Reality of Science Studies*, Cambridge, MA: Harvard University Press, 1999. For an argument against the notion of transparency in today's algorithm criticism: Kathrin Passig, »Fünfzig Jahre Black Box,« *Merkur. Deutsche Zeitschrift für europäisches Denken*, 823 (12/2017), 16–30.

136 Gitelman, Jackson, »Introduction,« 9. David Gugerli summarizes the relational database model outlined by Edgar F. Codd in the 1970s as follows: »All data in a relational database system must be able to be represented by a connected set of clearly designated tables, so-called relations. Within each relation there would be clearly designated columns. The order of the rows plays no role, but each row represents an addressable element of the entity denoted by the relation. It must be distinguishable from others and may only appear once« (David Gugerli, *Suchmaschinen. Die Welt als Datenbank*, Frankfurt/Main: Suhrkamp, 2009, 77).

137 Ibid., 71.

made concretely productive. Against the »etymological legacy«[138]—derived from *datum*: that which is given—data are fundamentally created on various levels, or lifted by queries and connecting operations from the entirety of a data pool, as amorphous as it is opaque: »Data need to be understood as framed and framing, understood, that is, according to the uses to which they can be put.«[139] This aspect, which Gitelman interestingly describes using the terminology of photographic framing, is strongly emphasized by Sebastian Gießmann and Marcus Burckhardt: »[…] the fact that data always seem to be given *for* something: *for* their later interpretation, *for* their technological evaluation by computers, *for* future access, and *for* the understanding of reality.«[140] The relative open-endedness of data manufacturing, which is crucial to relational data banks, is thus not least restricted by the layout, the efficacy of search machine functionalities, which, particularly under the conditions of big data, not only produce all sorts of connections, but also oversight and hierarchy.

Thus already from the viewpoint of standardized data collection in the form of relational data banks, the »major trend toward datafication«[141] that can be observed on various levels, including in the field of the image—a spectrum that in the context of this study ranges from digital technologies of acquisition and transcoding to streaming video codecs and the data-image-sensory environmental calculations of the Internet of things—describes a dynamic transport process, guided by perspectives of evaluation.[142] Data sets here are assigned a discrete key in order to render them capable of being algorithmically processed, manifest, and distributed.

Under the real-time conditions outlined here, which process and distribute ever increasing amounts of data in stream form, this fundamental mobility is naturally further intensified, thus requiring data management architectures that are aimed at transmitting and processing in real time. Christoph Engemann describes the pressure this puts on logistical infrastructures in terms of social media application contexts:

138 Marcus Burckhardt, Sebastian Gießmann, »Was ist Datenkritik? Zur Einführung,« *Mediale Kontrolle unter Beobachtung* 3.1 (2014), 1–13, https://www.medialekontrolle.de/beitrage/was-ist-datenkritik-zur-einfuehrung/, here: 2.

139 Gitelman, Jackson, »Introduction,« 5.

140 Burckhardt, Gießmann, »Datenkritik,« 9 (italics in the original).

141 Ibid., 7.

142 Cf. Stefan Böhme, Rolf F. Nohr, Serjoscha Wiemer, »Einleitung,« in: Böhme, Nohr, Wiemer (eds.), *Sortieren, Sammeln, Suchen, Spielen. Die Datenbank als mediale Praxis*, Münster: LIT Verlag, 2012, 9–29, here: 11f.

>›Firehose‹ is the informal term for the dense, practically violent stream of data that aggregates in the data banks from end devices. […] The data banks are like reservoirs into which the data flows, both coming to rest there as well as escaping once again at high speed, filtered and at defined points.[143]

In the ›real-time web‹ it has already been some time since the term ›streaming data‹ referred solely to the transmission of data that—as in the case of audio-visual signals—have a distinctive, concretely perceivable temporal behavior. In contrast to static data, which are managed in relational data banks, streaming data are temporally organized, continuous, unrestricted, non-persistent, as well as being comparatively loosely structured, which necessitates corresponding systems of live processing. Data stream algorithms with the capacity for sequential reading and processing therefore no longer operate in DBMS infrastructures, but rather in so-called Data Stream Management Systems (DSMS). Between incoming and outgoing streams there is a time-critical specification profile oriented toward sequential access: to manage continuously new data that is constantly being restructured, analyze it and make it accessible in real time.

As Byron Ellis has stated, the evolution of the associated flow management began with monitoring network infrastructures: the surveillance of the physical state of processors and ventilators by servers in data processing centers. Commercial web analytics applications—at first on the basis of sequential batch processing—were added later (at the front end: to track user behavior,[144] implement recommendation systems on the basis of analyzed browser histories, etc.), before the web's attention economy was then

143 Christoph Engemann, »You Cannot not Transact—Big Data und Transaktionalität,« in: Ramón Reichert (ed.), *Big Data. Analysen zum digitalen Wandel von Wissen, Macht, Ökonomie*, Bielefeld: Transcript, 2014, 365–381, here: 373. A technological consequence of these data-intensive stream conditions is the transition to so-called NoSQL database architectures, which follow a non-relational, less consistency-oriented paradigm (BASE); cf. ibid., 366ff.

144 In the following, tracking is understood in Philip E. Agre's sense as a general »metaphor« for registering and following data traces: »[T]he entity in question traces a trajectory through a more abstract space which might have numerous ›dimensions‹« (Philip E. Agre, »Surveillance and Capture: Two Models of Privacy,« *The Information Society* 10/2 (1994), 101–127, here: 104f.) On the distinction between tracking (recording position) and tracing (retracing a path) in relation to geomedia, see Johannes Paßmann, Tristan Thielmann, »Beinahe Medien: Die medialen Grenzen der Geomedien,« in: Regine Buschauer, Katharine S. Willis (eds.), *Locative Media. Medialität und Räumlichkeit—Multidisziplinäre Perspektiven zur Verortung*, Bielefeld: Transcript, 2013, 71–104, here: 89ff.

revolutionized with »real-time bidding infrastructures.«[145] In this system ›real time‹ is in a certain sense a relative concept of informational performance, effectively decoupled from any ›liveness‹ that is directly relevant to perception. The requisite processing power is dependent on the stream velocity of the data movement imparted by the DSMS, that is, not on temporal media contexts, which in one form or another could still be reliant on models of perceptual coding, an antecedent modeling of the perceptual capacities of end users:

> [T]he fact that data is always flowing means that the system needs to be able to keep up with the data. If 2 minutes are required to process 1 minute of data, the system will not be real time for very long. Eventually, the problem will be so bad that some data will have to be dropped to allow the system to catch up. In practice it is not enough to have a system that can merely ›keep up‹ with data in real time. It needs to be able to process data far more quickly than real time.[146]

The narrower sense of datafication of image phenomena that is of interest here also points to temporalized aggregate states in spheres of media organized in stream form. As an element of the data stream, a visual data set flows through the channels of the general flow management, is continuously analyzed and forwarded, coupled with real-time analysis tools (such as the aforementioned bidding infrastructures), and made available to constantly updated data interfaces. Datafication is a multiform phenomenon: wherever there is a data image, differently formatted data streams, generated in parallel and instrumentalized to specific ends, are not far off. The quasi-internal temporality of the distributed image, initially defined by bitmap structures, compression algorithms, and network protocols, is continuously synchronized with ambient flow dynamics. Its manifestations are contingent—and, as outlined above, are in part dependent on transmission capacities. Insofar as the real times implemented are meant to arrive at user interfaces, however, variously

145 »For these applications, the money being spent in different environments and on different sites is being managed on a per-minute basis in much the same way as the stock market. […] When a visitor arrives at a website via a modern advertising exchange, a call is made to a number of bidding agencies (perhaps 30 or 40 at a time), who place bids on the page view in real time. An auction is run, and the advertisement from the winning party is displayed. This usually happens while the rest of the page is loading; the elapsed time is less than about 100 milliseconds. […] All the parties in this process—the exchange, the bidding agent, the advertiser, and the publisher—are collecting data in real time for various purposes« (Ellis, *Real-Time Analytics*, 4).

146 Ibid., 7.

compensated temporal differences are fundamental, even beyond adaptation capacities—if only because data as a rule have to be visualized as »beautiful« in order to be operable from the user's perspective, as Orit Halpern has observed.[147]

The remark by Claus Pias cited at the beginning of this study, »that digital images have information,«[148] regardless of the concrete layout of temporally flexible ›real-time speeds,‹ requires further substantiation from a logistical perspective—namely, with regard to that layer of data specifically used by distribution calculations: so-called metadata. These are essentially ›data about data,‹ which localize and authorize the data image on the one hand, and on the other allow it to be addressable, distributable, and—within limits—machine-readable (metadata therefore also play a critical role in the development of the semantic web, in the course of the anticipated determination of meanings and relations of individual contents). Behind data that are formatted as raster graphics and can therefore be output accordingly, there are data that contain, for instance, spatial, temporal, and transmission information. In this way the image is opened up to information technology: to indexing and search engines, to locating, to calculating possible orbits. Beyond the data directly implemented in image processing and visualization, there are also data that are primarily identified and processed by the transmission processes relevant to the technologies of traffic. From this perspective, where, through which channels, in which configuration an image streams forth, has to do with information that is not subsumed in the visual ›content‹ (the pixel values) but nonetheless belongs to it. Conversely: image data sets without metadata tend to be dysfunctional from a logistical perspective—anonymous datagrams, opaque packets without an identifiable transport connection. If additional information formatted in such a way is lacking, entry into the general traffic volume of searching, finding, transmitting is hampered or even blocked—circulation requires data about data in order to get underway.[149]

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147 »[I]n our present a visualization is understood as being out of time and space, nonsychronic with the event it is depicting, translating, comprehending, and guiding. This nonsynchronicity preoccupies our imaginings of ›real-time‹ interactivity and data visualization, driving a constant redefinition of the temporal lags between collecting, analyzing, displaying, and using interfaces« (Orit Halpern, *Beautiful Data: A History of Vision and Reason since 1945*, Durham, NC: Duke University Press, 2015, 22).

148 Pias, »Das digitale Bild.«

149 The formula »data about data,« however, tends to conceal the fact that the implied boundary between metadata and ›content‹ has itself become unstable, as Götz Bachmann and Yuk Hui have noted: »As data about data, metadata is data about content. However, increasingly metadata becomes content itself. To take an example that is already very familiar to all of us: on video platforms such as Youtube, the representation of the number

A distinction is usually made here between descriptive metadata and metadata that result from administration on the one hand and on the other from the transactional usage of an image data set as well as the modes of its network-based distribution. Descriptive metadata can be understood as the product of a hyperindexical datafication, insofar as this includes above all spatial and temporal information about image acquisition, that is, alongside the time of creation (of the image as well as the file activation) also georeferenced data on the location of the image. In addition to these automatically generated metadata, stored as integral to the file and coded as a numerical cross section of space-time, so to speak, there is also JPEG-based media-technical information on the exact size of the data set, the device model used (and its serial number), the color profile, focal length, f-stop, exposure mode, exposure time, as well as administrative access rights (and later: editing history). These metadata are saved in Exchangeable Image File Format (Exif), a standard that facilitates processing and editing metadata, which numerous Exif tools and web services work with, extracting GPS data, for instance, in order to locate images through digital cartography. According to Jeffrey Pomerantz's definition, administrative metadata subsume structural metadata and preservation metadata, which, alongside data origin—for image data this intersection with descriptive metadata would typically consist of further information on acquisition or transcoding—primarily relate to the internal construction of the data set and the specific hardware and software requirements that are necessary to mobilize or to emulate it.[150] In the case of MPEG files, the structural metadata stored in the header contain the crucial logistical specifications concerning the order in which the data are to be called up for them to be properly and punctually transported to the screen as a multimedia file.

of users, who have formerly watched a video (e.g.: ›Views: 604,233‹), becomes part of the user experience. […] Social networking sites, for example, often turn data about users automatically into metadata. Again, we can observe here a blurring of the boundaries of data and metadata. In advanced versions of the semantic web each website provides well-structured and machine-understandable metadata about other websites linked or otherwise connected to it—and vice versa. Whilst this in itself is nothing new—in a way links have always created a form of metadata about websites—it gains a new momentum when computers have access to each website's metadata: Now the metadata of website A becomes part of the description of website B and vice versa« (Götz Bachmann, Yuk Hui, »Metadata Project: What We Want to Do!« *Project 2: Metadata in the Age of Ubiquitous Media*, 2008, https://www.gold.ac.uk/media/documents-by-section/departments/research-centres-and-units/research-centres/leverhulme-media-research/Metadata0_outline.pdf, 3f.).

150 Jeffrey Pomerantz, *Metadata*, Cambridge, MA: MIT Press, 2015, 17f.

Another layer of metadata, which needs to be distinguished from this, does indeed adhere to the nominal image data set, but is stored as fundamentally separate, in proprietary data banks.[151] It does not derive from the context of acquisition, but rather accumulates distribution-related data—and data that result from image-sharing practices on social media, that is, for instance, individually or collaboratively generated tags[152] or information-economic values such as numbers of queries and dissemination (ratings, likes, views, retweets, etc.[153]). Especially for platforms such as Facebook, images are primarily of interest as digital metadata objects, by means of which profiles and the surrounding social media network can be regulated »governmentally«[154] and data mining processes can be supplied. It is metadata that place images in relation to one another, correlate them, network them. The positioning, searchability and distributability, the traffic footprint of an image within visual culture are defined by layers of data that themselves are not ascribed to the register of the visual, that cannot contain or generate any iconic component. Instead of expanding »the application of visual representation to the image search itself,« the rule here is: »A written notice, a date, a place determines what can be remembered as an image. Images are thus actually addressed not as something visual, but as an illustration of a search word.«[155] Tagging, a user-generated »inscription« (Walter Benjamin)[156] of the image popularized on social media, adds to this arbitrarily definable metadata material in text form, promotes indexing and

151 Cf. ibid., 57.

152 »An untagged image is worthless, as it is invisible to search engines and cannot enter the economy of the search industry« (Daniel Rubinstein, »Tag, Tagging,« *Philosophy of Photography* 1/2 (2011), 197–200, here: 198).

153 Cf. Carolin Gerlitz, »Die Like Economy,« in: Oliver Leistert, Theo Röhle (eds.), *Generation Facebook. Über das Leben im Social Net*, Bielefeld: Transcript, 2011, 101–122.

154 Caplan, *JPEG*, 169ff. In his informative analysis of the patent history of Facebook's Open Graph API, Caplan analyzes the central role of the metadata of digital images: »Images and tags become data elements or objects. What is more the connections themselves become data objects [...]. The relationship engine continually generates, or helps us generate, new orders, new connections, new relationships which are fed back into the engine as new data objects open to yet more orderings, connections and relationships [...]. Images and imaging are a key part of the engine, as evidenced in both the timeline and tagging patents« (ibid., 163f.).

155 Wolfgang Ernst, Stefan Heidenreich, Ute Holl, »Editorial. Wege zu einem visuell adressierbaren Bildarchiv,« in: Ernst, Heidenreich, Holl (eds.), *Suchbilder. Visuelle Kultur zwischen Algorithmen und Archiven*, Berlin: Kadmos, 2003, 7–15, here: 12.

156 Walter Benjamin wrote presciently: »Won't inscription become the most important part of the photograph? [...] The first people to be reproduced entered the visual space of photography with their innocence intact—or rather, without inscription.« (Walter Benjamin, »Little History of Photography,« *Walter Benjamin: Selected Writings*, Volume 2, 1927–1934, Cambridge, MA: Harvard University Press, 1999, 507–530, here: 527, 512).

identification without requiring that patterns become machine-readable in the strict sense.[157]

However, current processes of automatic image recognition on the basis of artificial neural networks (ANNs) aim to replace this control function of conventional metadata—which determine how, but above all also what, under which semantic label a digital image data set circulates, in which configuration it appears, for which search terms—with algorithms formed through deep learning.[158] These are meant to recognize objects in images or patterns in bitmaps: »They can tell what's in an image by finding patterns between pixels on ascending levels of abstraction, using thousands to millions of tiny computations on each level. New images are put through the process to match their patterns to learned patterns.«[159] Adrian Mackenzie has described this automatic process of image recognition (actually, to be more precise, image classification) with regard to the ›cat picture radar‹ kittydar:

> Faced with the immense accumulation of cat images on the internet, kittydar can do little. It only detects the presence of cats that face forward. It sometimes classifies people as cats. […] [T]he software finds cats by cutting the image into smaller windows. For each window, it measures a set of gradients […] running from light to dark and then compares these measurements to the gradients of known cat images (the so-called ›training data‹). The work of classification according to these simple categories of ›cat‹ and ›no cat‹ is given either to a neural network […], themselves working on images of cats among other things taken from YouTube videos, or to a support vector machine.[160]

157 The prehistory of the practice of tagging includes the metadata standard IPTC (International Press Telecommunications Council), established in the late 1970s for journalistic use, which was then developed further in 1991 as the IPTC-IIM standard, storing legal licensing information as well as textual information such as image descriptions and keywords within the format. On user practices of »social tagging« in general, see Jennifer Trant, »Studying Social Tagging and Folksonomy: A Review and Framework,« *Journal of Digital Information* 10/1 (2009), 1–42.

158 Cf. generally Adrian Mackenzie, *Machine Learners: Archaeology of a Data Practice*, Cambridge, MA: MIT Press, 2017; and Andreas Sudmann, »Szenarien des Postdigitalen. Deep Learning als Medienrevolution,« in: Mackenzie, Christoph Engemann (eds.), *Machine Learning. Medien, Infrastrukturen und Technologien der Künstlichen Intelligenz*, Bielefeld: Transcript, 2018.

159 Gershgorn, Dave. »It's Not about the Algorithm: The Data that Transformed AI Research—and Possibly the World.« *Quartz*, July 26, 2017. https://qz.com/1034972/the-data-that-changed-the-direction-of-ai-research-and-possibly-the-world/.

160 Mackenzie, *Machine Learners*, 4f.

The automatic identification, classification, and annotation of visual content[161] brought in against the flood of digital cat pictures is now also supplemented by more complex captioning systems, which, like Google's Inception V3 model, train object identification and descriptive language in parallel.[162]

Informational objects of distribution-related ›image readings‹—a kind of ›very distant viewing‹ of distribution channels[163]—are currently still primarily metadata that are either embedded deep within the image data set (Exif formatted values such as geocodes), or laminated, as it were, to the packet's outer layers (some are loosely attached, such as platform user tags, alt tags in HTML code, or even more loosely: running texts, evaluated by search engines, that surround an image on a website, presumably identifying it; others are not as easy to detach, such as accumulated transmission data or views, retweets, etc.): »When digital content and its description becomes inseparable, change in metadata can be seen as part of a change of the object itself.«[164] For this reason, in the context of recent discussions of networked photography, the context relevant to analyzing images is expanded into data environments that can for their part be »noisy«:

> As the digital image traverses the network it brings forth new opportunities for classification, new assemblages, new aggregations. The digital-born image is never singular, it appears in series, repetitions, sequences, rapid volleys [...]. Each retweet, reblog, rating or tag generates further metadata which can amplify the intensity of the image, its reproducibility, and create topologies between images. With respect to Flickr, the simple act of tagging an image ›cat‹ immediately connects the image

161 »Aiming to transform the way in which people search and browse theirs and others' photos, these systems automatically analyze and recognize searchable visual content such as objects, text, or faces and automatically add searchable tags to images and videos where those items are ›seen‹ by the software. These types of visual data management are becoming ever-more synchronous with the act of picture taking within and outside of the stream and operate both on the level of the individual's image collection and over collective datasets from many people. They offer to group small and large sets of images based on inherent content attributes and then divide these visual sets according to various categories« (Hochman, »Social Media Image,« 4).

162 Cf. James Walker, »Google's AI Can Now Caption Images as Well as Humans,« *Digital Journal*, Sept. 23, 2016, http://www.digitaljournal.com/tech-and-science/technology/google-s-ai-now-captions-images-with-94-accuracy/article/475547.

163 Cf. Franco Moretti, *Distant Reading*, New York: Verso, 2013. On approaches to digital humanities in media studies, cf. David M. Berry, Anders Fagerjord (eds.), *Digital Humanities: Knowledge and Critique in a Digital Age*, New York: John Wiley & Sons, 2017. More on this complex in chapter II.3 (Computing Video Data).

164 Bachmann, Hui, »Metadata,« 6.

> (whether it depicts a cat, dog or fish) with 100,000 other photos of images deemed to have a relationship to the term ›cat,‹ which can be brought to the screen with a casual click [...]. Within such platforms there is no static viewpoint, no distinct separation between spectatorship and authorship, but an array of temporary constellations of images which are activated by users. The presentation of images from the underlying database is dependent on the sensitivity of the image to the search query, associated metadata and specific parameters coded into the interface.[165]

The data image's potential meaning shifts during its movements through the transmission channels, proceeding in relation to the data-topological regroupings that are implemented there. From the perspective of logistics, this is a temporary storage practice made dynamic through permanent inflows and outflows, in which goods never stay very long at the same ›place‹ (and this place, for its part, is constantly reorganizing itself), yet every transport movement can nonetheless be followed in minute detail.

Consequently, the significance of metadata outlined here in part indicates that the datafication of the image is not limited to the creation and storage of digital visual objects, nor to those algorithms from which image reproduction software, image editing software, and, more recently, image recognition software assemble their command architectures. Indeed, the transmission processes themselves are also datafied. Image data traffic distributes data, but in so doing also constantly creates new data. Distribution in itself is genuinely data-productive. It is image traffic data that accumulate as transmission traces, continually expanding the data records of a particular image. Image queries, image use, image reception become countable and calculable in novel ways, which is why image distribution feeds big data, »now that every click, every move has the potential to count for something, for someone somewhere somehow.«[166] From a logistical perspective, transport data, which on the one hand control distribution and on the other hand make it inscribable, reproducible, trackable, are significant above all because they contain a promise of optimization. Data that relate to the mobilization of transport goods—the »movements of images«—can be recorded, evaluated, and used to increase logistical efficiency (in reality: for correlative big data analyses).

165 Daniel Rubinstein, Katrina Sluis, »Notes on the Margins of Metadata; Concerning the Undecidability of the Digital Image,« *Photographies* 6/1 (2013), 151–158, here: 155.

166 Gitelman, Jackson, »Introduction,« 2.

Under network conditions, digital images therefore have information that is both calculated and produced in the distribution channels. In the subsequent distribution sequence the data packet is accordingly enriched and rearranged case by case. For traffic data captured in this automatic way, for the first time in the history of media-technically generated images, the crucial matter is that they inscribe themselves accumulatively in the images, are a practically inseparable part of them as a continuously registered distribution history. The transport, reception, and further dissemination of an image no longer wear away at it, but now count as something, can be numbered, computerized, (re)calculated in nearly any manner. Every such transmission operation leaves behind digital traces that are informative and powerful in reality, but no longer manifest as ›analog‹—in the sense of an immediately perceivable inscription on a carrier material like celluloid film, for instance. Viewed in terms of material aesthetics, transmission protocols—which facilitate distribution and communication as well as storing them in the form of technological documents—as media-technical traces can be completely abstract, undetermined, easy to overlook. However, they can neither be switched off nor erased post-distribution with any final certainty—they can only be complicated with regard to their readability, namely, encrypted. But, as the next chapter will show is true for digital image data, too: they stream out mediated by memory—and fill up memory with stream data.

I.3 Storing (Memory)

Logistics, as stated at the beginning of this discussion, deals with questions of distribution, with the organization and execution of transport tasks. The infrastructure for moving information goods includes not only adequately developed traffic routes and those transport agents that effect mobilization *in actu*, but also distribution-related memory processes. To begin with, this would subsume methods with which transport goods are transferred in states of relative stability while in motion—for instance, packet standards or containers,[167] which on the one hand securely store the freight during transmission, and on the other first bring it into a form, into a format compatible with the given infrastructural conditions of distribution. A further dimension of memory concerns the fact that goods are demobilized—in logistical terminology: deposited—before and after the transfer. From the viewpoint of certain storage agents, the transport process merely signifies a relocation: from starting point A to a (provisional) endpoint B. In the meantime—that time in which precisely no transfer takes place—the depositum is to be stored such that it can be efficiently remobilized without unnecessary delay. Depots with this organizational competence specialize in accessibility and cache memory. They do not simply collect goods for purposes of accretion or even final storage, but keep them for distributive agendas. Ideally, in terms of transport economics, depots are thus integrated in the operationalized network of routes such that delivery can occur in every direction without detours. The transport process, the phase between check-in and check-out, is interrupted in the depot state, but continues to be effective as a regulative idea. Depots are »transitory spaces and buffers,«[168] in short, storage spaces whose memory functionality should be conceived within the context of distribution.

The following will be concerned less with the empirically certain proliferation of digital image collections, the exponential growth of photo and video data pools in themselves, than with the related technologies and practices of distribution, which are then necessarily reconfigured when »the forces of administration and exploitation intervene in a medium […] and simple visual prostheses (such as videotelephony or video livestream) become image

167 Cf. Marc Levinson, *The Box: How the Shipping Container Made the World Smaller and the World Economy Bigger*, Princeton: Princeton University Press, 2008. On container formats (and codecs) see chapter III.3 (Video Signal Histories).
168 Dommann, »Handling, Flowcharts, Logistik,« 81.

memory.«[169] The expanded depot architectures as they are configured today include first and foremost data centers where servers store, administer, and output data sets upon request. The data banks operating there are on the one hand digital collection technologies, but on the other are also always data memory banks.[170] As a dynamic storage system they are conceived for algorithmic access in terms of their structural logic, thus do not so much hold data securely as make it permanently available.

In this way, formats, servers, data banks connect modes of immobilizing data in various mixing ratios—formatted according to compression algorithmic rules, hosted for client access, located by a unique tabular key—with structures and parameters of their processual traffic form. A ›data flow‹ conducted in this way is constituted as neither immaterial nor without memory. Even the fluid dynamic of the data stream itself develops in relation to ›saved‹ infrastructural parameters, which embed and channel it so that adaptive feedback—such as the communication of transmission capacities—is possible.

How stream and memory relate to one another against this backdrop can be described in more detail on the basis of information-technological processes whose memory functions should be understood less as diametrical to flow, and not as methods of locking data, but more as arising from the distribution dynamics themselves and to a certain degree cooperatively linked with them. This then brings into view forms of data traffic that, despite all rhetoric of conveyance, precisely do not operate in an uninterrupted, ephemeral or traceless manner. On the one hand, data streams carry with them material that is calculated for the memory interests of distribution technology. On the other, distribution is not a one-way street, but triggers variously formatted and exploitable return shipments. This speaks to two things in relation to analyzing memory: the economy of return data memory and the cache memory that comes into effect during the distribution process.

In a neuralgic passage of his analysis of recent content delivery systems, Christian Sandvig cites J.C.R. Licklider as a key witness in the archaeology of media. In a comparatively peripheral research paper (entitled »Televistas«), the psychologist and computer scientist examines the dominant »one-way

169 Matthias Bruhn, *Bildwirtschaft. Verwaltung und Verwertung von Sichtbarkeit*, Weimar: VDG, 2003, 123 (italics in the original).

170 According to Marcus Burckhardt the database is distinguished from other forms of collection like the library, the archive, or the museum first and foremost by its specific data management system, but nonetheless is not to be dismissed from the field these forms invoke, already in their terminology, which encompasses collection technology and memory (cf. Burckhardt, *Digitale Datenbanken*, 117ff.).

distribution network« of the 1960s in terms of the relationship between downstream and upstream realized therein. In his view, the accordingly widespread mass communication content was characterized above all by a structural feedback deficit: »broadcast stations transmit to viewers who do not transmit back.«[171] Licklider's countermodel (»hard copy television«) aimed at an alternative distribution process that, in facilitating selective, temporally flexible (and partially also interactive) access, not only envisioned converting ›transmission‹ into ›content‹ (that is, from televisual flow to video on demand), but already anticipated later network architectures. As Sandvig also explains, the counterbalancing relativization of conventional provider–consumer asymmetries (intended as emancipatory in Licklider) has obviously not become reality, due to the tendency toward »retrofitting« distribution channels—and in general due to the hegemony of the »stack.«

In this context, what nonetheless appears more relevant than ever is the question of status and layout of those data streams that flow back synchronously from users to providers during consumption. This is not so much a matter of the content that users are allowed to feed into the content management systems of the five currently leading media corporations through interface parameters,[172] nor is it a (skeptical) diagnosis of how content creation realized on the part of the user relates to the communication opportunities that a few years ago were still being promoted as the unique feature of the so-called Web 2.0. What is more informative and consequential are those streams that allow today's data traffic, independent of intentional uploads (images, texts, profile specifications, etc.), to become a downstream economy whose business model is based at its core on eliciting, storing, and managing specific upstreams through data mining: »the user becomes a source of data too, essentially a real-time stream themselves, feeding their own […] data stream into the cloud, which is itself analysed, aggregated, and fed back to the user and other users as patterns of data.«[173]

The correlative pattern recognition associated with the concept of big data is fundamentally based on »technologies of data acquisition and processing.«[174] The process of acquisition includes—as a requirement for processing—automated data practices of collecting. Without memory there is no mining,

171 Sandvig, »Internet as Anti-Television,« 229.

172 Cf. Warnke, »Datenbanken als Zitadellen,« 133ff.

173 Berry, »Messianic Media.« Cf. also Till A. Heilmann, »Datenarbeit im ›Capture‹-Kapitalismus. Zur Ausweitung der Verwertungszone im Zeitalter informatorischer Überwachung,« *Zeitschrift für Medienwissenschaft* 13/2 (2015), 35–47.

174 Ramón Reichert, »Einführung,« in: Reichert (ed.), *Big Data. Analysen zum digitalen Wandel von Wissen, Macht, Ökonomie*, Bielefeld: Transcript, 2014, 9–31, here: 11.

no operating field for »algorithmicity,«[175] which both extracts and aggregates information from vast arrays of unstructured data: »Processing the data is one thing, but for it to be delivered to the end user it needs to be stored somewhere. […] [I]t is usually desirable to persist results to tertiary storage (disks or ›cloud‹ storage devices) so that the data may be more easily analysed for long-term trends.«[176] These data are increasingly being stored in memory for the long term, not least because their full utilization potential cannot be foreseen at the time of acquisition. The (commercial, diagnostic, prognostic) value of a data pool shifts with newly acquired data, which then enrich the pool further and make »innovative secondary uses«[177] of older pools possible, which is particularly problematic in terms of data privacy.[178]

The correlative calculation applied here draws on memory banks that are primarily filled by consumers who regularly pay for the service requested from a server (›data reception‹) with a currency that, from the perspective of transmission, is a return shipment from the client, and hardly ever made transparent (›data delivery‹).[179] Ed Finn has called the fundamental informational-hierarchical logic »algorithmic arbitrage,«[180] meaning an exploitation of differences in rates that feeds on a spiral of intensified datafication,

175 Cf. Felix Stalder, *Kultur der Digitalität*, Berlin: Suhrkamp, 2016, 164ff. For a warning against essentializing the algorithm in media and cultural studies, see Paul Dourish, »Algorithms and their Others: Algorithmic Culture in Context,« *Big Data & Society* 3/2, July–Dec. 2016, 1–11.

176 Ellis, *Real-Time Analytics*, 167. On the NoSQL memory systems preferred in the context of big data, cf. ibid., 169ff.

177 Mayer-Schönberger, Cukier, *Big Data*, 153.

178 Cf. ibid., 152–170.

179 Cf. Ramón Reichert, »Facebooks Big Data. Die Medien- und Wissenstechniken kollektiver Verdatung,« in: Reichert (ed.), *Big Data. Analysen zum digitalen Wandel von Wissen, Macht, Ökonomie*, Bielefeld: Transcript, 2014, 437–452.

180 »When you access a website, perhaps to find out what is happening in the world ›right now,‹ hundreds of servers are involved in auctions lasting fractions of a second to determine which advertisements will appear on the page, and maybe even organize its content according to models predicting your interest in different topics. Algorithmic arbitrage depends on gaps of understanding and cultural latency to generate profit or valuable information. […] [T]he unexamined bargains we make to share our personal data streams with companies like Facebook and Google depend on such forms of arbitrage, bringing us meaningful cultural data (HOUSE OF CARDS, curated news about family and friends) in exchange for other information (our interests, locations, search histories, viewing habits, etc.) whose value is effectively unknown to us, but known to the companies providing these services. Algorithmic arbitrage succeeds most completely when we adopt the grammars of information that they espouse« (Ed Finn, *What Algorithms Want: Imagination in the Age of Computing*, Cambridge, MA: MIT Press, 2017, 97).

insofar as data relations are continually exchanged against untransparent self-datafying transfers. The consumption of image data that can be called up, viewed, for instance, on a photo or video sharing platform without a ›streaming ticket,‹ is confronted as an economic calculation not only with display formats that are more or less voluntarily absorbed along with these data, but also with the implicit transactional consent[181] to allow oneself to be datafied in a variety of dimensions while viewing the image. In John Lanchester's words: »You are the product.«[182]

Memory here implies: Data reception becomes solidified as the data trace. Continually expanded, refined data profiles[183] can be siphoned off in manifold ways (and variously anonymized), marketed, retained for later use, or factored into user addressing in the future: »memory becomes the object of an added value of a second order.«[184] The cybernetic principle of »feeding back« addressed by David Berry is prominently used, for instance, in the personalized recommendation algorithms of a provider like Netflix, which fragments its catalog into all sorts of microgenre-analytical elementary particles in view of a data pool of streaming history that grows second by second, projecting them back in ever new categorizations to image viewers who are ever more subtly captured. The filter algorithms employed are themselves the results of exploiting memory: »Netflix doesn't care if ›you‹ like something. Netflix cares whether or not ›you‹ stop streaming. The Netflix algorithm has actually moved

181 Christoph Engemann describes the logic of this »transaction-cost-oriented economy« as follows: »Big data is a transaction machine that promises to make a transaction of every piece of data, every communication. Accordingly, one can no longer not transact, although one is seldom aware of the transactional dimension of one's own actions. The voluntary act of transaction is brought forward in the act of accepting the terms of use. Once these are clicked away, one's own actions and inactions reliably enter into transactions that are completed at different places by different agents and to an incalculable degree« (Engemann, »You Cannot Not Transact,« 377).

182 John Lanchester, »You Are the Product,« *London Review of Books* 39/16 (August 17, 2017), https://www.lrb.co.uk/the-paper/v39/n16/john-lanchester/you-are-the-product.

183 In terms of technology, the application programming interfaces (APIs) of quasi infrastructure providers like Facebook play a crucial role: »when users authenticate to websites or applications using their Facebook identities, the API records these acts to their Facebook data profiles. Having access to this identity, many applications then silently contribute to the social graph via the API, extracting data from our shopping habits or information-seeking behavior and sending it along« (Plantin, Lagoze, Edwards, Sandvig, »Infrastructure Studies Meet Platform Studies,« 15).

184 Christoph Neubert, »Speichern,« in: Heiko Christians, Matthias Bickenbach, Nikolaus Wegmann (eds.), *Historisches Wörterbuch des Mediengebrauchs*, Cologne: Böhlau, 2014, 535–555, here: 551.

away from ratings: It doesn't care what you say you like because it has a record of all your actions.«[185]

This adjustment to the recommendation system, driven in part by a programming competition launched for marketing purposes,[186] coincided with a media-logistical paradigm shift. A rental distributor that was still mailing out over a billion DVDs in 2007, the year of the transition, became a digital data distributor. As a »cultural machine« (Ed Finn), the streaming service Netflix no longer drew on user-generated evaluation practices, but on reception histories logged and reviewed in great detail: on viewer datafication. The distribution information that now accrued with every streaming operation multiplied the data points that had previously consisted only in the borrowing transaction, generated information-saturated data streams of usage flowing back, and facilitated a rebranding of the media company, which is valid to this day, under the banner of »instant access« and an algorithmically optimized personalization: »this also means we are no longer identified according to metrics we might choose ourselves (e.g., what we elect to share on a consumer survey) but according to a set of behavioral choices whose consequences are largely unknown.«[187]

In this form of »data behaviorist«[188] measurement of the viewer, personalization, profiling,[189] and identification are fundamentally offset by an expanded statistical pool.[190] The individual user is constructed correlatively or ›collaboratively,‹ that is, not solely on the basis of his or her own data trail history,

185 Wendy Hui Kyong Chun, Brian Droitcour, »To Be Is to Be Updated: Somehow This Is Caring,« conversation recorded at »To Be Is to Be Updated« (February 12, 2016), published March 17, 2016, https://www.canopycanopycanopy.com/contents/to-be-is-to-be-updated?sub=somehow-this-is-caring.

186 Blake Hallinan, Ted Striphas, »Recommended for You: The Netflix Prize and the Production of Algorithmic Culture,« *New Media & Society* 18/1 (June 23, 2014), https://doi.org/10.1177/1461444814538646.

187 Finn, *What Algorithms Want*, 109.

188 Cf. Antoinette Rouvroy, »The End(s) of Critique: Data-Behaviourism vs. Due-Process,« in: Mireille Hildebrandt, Ekatarina De Vries (eds.), *Privacy, Due Process and the Computational Turn*, New York: Routledge, 2012, 143–168.

189 Cf. Andreas Weich, *Selbstverdatungsmaschinen. Zur Genealogie und Medialität des Profilierungsdispositivs*, Bielefeld: Transcript, 2017; and Martin Degeling, Julius Othmer, Andreas Weich, Bianca Westermann (eds.), *Profile: Interdisziplinäre Beiträge*, Lüneburg: Meson Press, 2017.

190 With regard to related commodification calculations, Christian Sandvig has spoken of »corrupt personalization«: Christian Sandvig, »Corrupt Personalization,« *Social Media Collective* (blog), June 26, 2015, https://socialmediacollective.org/2014/06/26/corrupt-personalization/.

but through the continual integration of an ambient »collective statistical body«: of the entire data pool—likewise stored and analytically processed—of the streaming community, which is segmented into individual »clusters.« Drawing on Allan Sekula's theory of the »shadow archive,«[191] Wendy Chun has formulated the idea that in essence two old police photography techniques are interconnected here (we will return to these later): Alphonse Bertillon's anthropometric method of identification and Francis Galton's calculation of types, which is something like a pictorial statistics. In Bertillon's model, data from police identification records are measured, stored, and thereby individuated. Galton's composite images are concerned with classifying types, which do not serve forensic purposes, but rather are meant to develop prognostic effects. Chun formulates the overriding connection as follows:

> Facebook.com, Amazon.com and Google.com, among other sites, mine user data not simply to identify unique users but also, and most importantly, to see how their likes, etc., coincide with those of others. Collaborative filtering algorithms developed by Netflix.com and Amazon.com […] analyse and collect data in ways that suspend the difference between the individual and the collective body. […] This is why SNSs seek to be portals, for enclosing users within spaces is the easiest way to analyse and track these connections. […] These algorithms and this mining assume that the data being gathered is reliable; that users' online actions are as indexical as their body measurement and mug shots. […] To help ensure this correlation, which values users' actions over their words or ratings, websites create login structures that link a person to an ID.[192]

In the case of Netflix—the most comprehensive big data project to date in the history of moving images[193]—the datafication of image consumption is the central motor of continual distribution. Traffic itself becomes a commodifiable metadata product: distribution data that is extracted from the transmission

191 Allan Sekula, »The Body and the Archive,« *October* 39 (Winter 1986), 3–64, here: 10.

192 Chun, *Updating to Remain the Same*, 120.

193 Cf. Finn, *What Algorithms Want*, 87–112; Neta Alexander, »Catered to Your Future Self: Netflix's ›Predictive Personalization‹ and the Mathematization of Taste,« in: Kevin MacDonald, Daniel Smith-Rowsey (eds.), *The Netflix Effect: Technology and Entertainment in the 21st Century*, London: Bloomsbury Academic, 2016, 81–97; Sarah Arnold, »Netflix and the Myth of Choice/Participation/Autonomy,« in: ibid., 49–62; Alexis C. Madrigal, »How Netflix Reverse-Engineered Hollywood,« *The Atlantic*, Jan. 2, 2014, https://www.theatlantic.com/technology/archive/2014/01/how-netflix-reverse-engineered-hollywood/282679/; and Simon Rothöhler, »Kulturmaschinenserien,« *Cargo Film/Medien/Kultur* 36 (2017), 61–65.

channels and then played back into them. When the vertical integration of the major Hollywood studios was ended with the anti-trust law of 1948, the so-called »Paramount Case«—the oligopoly of the Big Five at the time was forced to limit its control over distribution: to give up their studio-owned movie theater chains—it was undoubtedly not even vaguely possible to foresee how radically vertical the control of audiovisual entertainment could be under the technological conditions of streaming, and how closed off the economic cycles would become within the walled gardens of contemporary platform politics (particularly since leading providers such as Netflix or Amazon have increasingly concentrated on in-house productions, which in a certain sense, as aesthetic objects, are also at least indirectly products of feedback signals taken from their in-house data mines).[194] Such recursively processed viewer datafication tailors the generalizing mathematical reception formulas of perceptual coding more and more precisely to individual perceptual activity, which is both data product and data generator within this dispositif.

The optimization of distribution channels, which, as has been shown, is substantially promoted by compression algorithms, has in part the goal of freeing up surplus broadband capacity for this form of data backflow production. In general, streaming technologies are set up so that they reduce the memory functions required by the client, while the servers queried at the beginning of the transfer are put in a position not only to output data, but to simultaneously withdraw it:

> Delivery is speeded up by streaming, in which the whole file is never delivered or cached by the end user and only the currently viewed parts of the video arrive at the end-user screen. Remaining bandwidth can then be used for interaction and for additional services that streaming

194 Bruno Latour drew attention to this »accumulation of traces« in relation to the difference between the novel and the online video game: »Apart from the number and length of reviews published, a book in the past left few traces. Once in the hands of their owners, what happened to the characters remained a private affair. If readers swapped impressions and stories about them, no one else knew about it. The situation is entirely different with the digitalisation of the entertainment industry: characters leave behind a range of data. In other words, the scale to draw is not one going from the virtual to the real, but a scale of increasing traceability. The stunning innovation is that every click of every move of every avatar in every game may be gathered in a data bank and submitted to a second-degree data-mining operation« (Bruno Latour, »Beware, Your Imagination Leaves Digital Traces,« *Times Higher Literary Supplement*, April 6, 2007, accessed at http://www.bruno-latour.fr/node/245).

> server software offers for traffic management, security, customer surveillance, and targeted advertising.[195]

While the user is served with the microtemporal caching[196] of a sequence of file fragments instantaneously performed by software during the streaming process, the transmission data synchronously flowing back—an information trail of user-related data, from the IP address to cookies, browser history, etc.[197]—remain in the nontransparent memory of the service providers, which in turn do not register this inverse transmission process as a stream (in the sense of the double movement of receive/discard), but record it as a ›whole file,‹ storing it long term for the reasons cited: »[O]ur movements [...] are increasingly being logged by the digital footprints that we leave behind as we pass through various electronic gateways.«[198]

The memory banks involved therefore tend to migrate into the surroundings. Local memory is replaced by the distributed memory architectures of the cloud, appearing as »transfer media«[199] from the viewpoint of the user, which do continue to have an address, but can no longer be concretely spatially localized. User behavior is thus routinely trackable, enriched with a history through repeated queries, a data shadow profiled on many levels,[200] which,

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195 Cubitt, *Practice of Light*, 251.

196 To what extent the volatile cache forms inherent to the streaming process can be viewed as at least temporary immobilizations of a ›copy‹ of the related data has often been the topic of copyright arguments (cf. Wolfgang Ernst, »Zwischen(-)Speichern und Übertragen. Eine medienarchäologische Analyse des digitalen Gedächtnisses,« in: Oliver Hinte, Eric W. Steinhauer (eds.), *Die Digitale Bibliothek und ihr Recht—ein Stiefkind der Informationsgesellschaft? Kulturwissenschaftliche Aspekte, technische Hintergründe und rechtliche Herausforderungen des digitalen kulturellen Speichergedächtnisses*, Münster: Monsenstein und Vannerdat—MV Wissenschaft, 2014, 85–108).

197 »The web turns out to be a technology that is so flexible and open that by adding new methods in the header of a request or response it can even introduce further layers that go well beyond what was originally planned as an information system without memory. With the aid of cookies, using the web writes a history of the user, but this history can only be read by the companies that run the servers« (Warnke, *Theorien des Internet*, 92).

198 Susan Schuppli, »Walk-Back Technology: Dusting for Fingerprints and Tracking Digital Footprints,« *Photographies* 6/1 (2013), 159–167, here: 160.

199 Neubert, »Speichern,« 550.

200 »A profile such as those Google (among others) creates captures the user on three levels: as a ›learning person,‹ who informs themself about the world (this includes, for instance, recording search requests, surfing behavior, etc.), as a ›physical person,‹ who finds themself in the world and moves in it (this includes, for instance, locating by means of smart phone, sensors in the smart home, or the gathering of body signals, and as a ›social person,‹ who interacts with other people (this includes, for instance, following activities on social media)« (Stalder, *Digitalität*, 189f.).

as mentioned above, experiences feedback that is still comparatively recognizable in the form of recommendation algorithms or other targeting, leading data customers deeper and deeper into the notorious »filter bubble.«[201] The provider, meanwhile, works to optimize a ›real time‹ that submits data storage and data processing to the technological ›simultaneity‹ of tools from the field of real-time analytics, as Felix Stalder has explained:

> In the server farms of the major providers there arises a new sphere of action in which users' behavior can not only be observed in the most minute detail, but also predicted to a previously unimagined degree, and—this is the crucial element—influenced. Here real time means that users' actions can be captured and processed with no time lag. The predictability of the users arises from the fact that the individual user's data are examined for repeating patterns, on the one hand, while on the other hand they are compared to the data of other users who executed a similar sequence of actions at an earlier point in time, and whose next action is therefore already known. As one firm that specializes in ›persuasion profiling‹ puts it: ›your next action is a function of the behavior of others and your own past.‹ This predictability, however, only works for relatively short periods of time. This means that the sooner the data are collected and the faster they can be reacted to, the greater the possibility of also being able to effectively influence.[202]

From the perspective of media studies, a noteworthy side effect of this customization, which reaches everywhere around itself on the basis of backflow data and tends to be instantaneous, is the methodological difficulty of outlining black box technologies (like all popular platforms and search engines), even vaguely, as epistemic objects.[203] The codes are proprietarily blocked and the

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201 Eli Pariser, *The Filter Bubble: How the New Personalized Web Is Changing What We Read and What We Think*, London: Penguin Books, 2013.

202 Felix Stalder, »Echtzeit: Die Temporalität der Post-Demokratie,« *n.n.—notes & nodes on society, technology and the space of the possible* (blog), March 29, 2016, http://felix.openflows.com/node/365. In this context Mark Hansen recognizes a general conversion of digital media technology from feedback systems to the anticipated futurity of »feed-forward« (cf. Mark B.N. Hansen, *Feed-Forward: On the Future of Twenty-First-Century Media*, Chicago: University of Chicago Press, 2015).

203 In reaction to this constellation, Jacob Ørmen has submitted a ›qualitative‹ suggestion based on experimentally simulated observer positions. The projected user is first prescripted conceptually and then observed quasi-ethnographically—for instance while interacting with Google's search engine service: »[W]hether one wants to conduct a longitudinal study or follow a short burst model, it is important to compare (or triangulate) the

applications themselves ›learn‹ so immediately that the algorithms involved register in a certain sense when they are being observed. The cached evidence of the interactions flows back via feedback into the (re-)positioning of a user, who is assigned a distinct kind of filter bubble based on the observed practice of observation. The fact that image data distribution occurs via selected channels and is routinely coupled with control technologies, is indeed also evident to the user in encounters with regional or copyright-based distribution barriers, such as geoblocking or digital rights management tools,[204] but the depth of memory and scope of exploitation employed in securing the traces of commercial data traffic alone seem to be significantly less a part of intuitive common knowledge.

As a mode of data transfer, streaming, on a number of levels, therefore cannot be described as a fleeting, traceless, almost self-denying outpouring of highly mobile bit packets. Distribution relies on memory—and fills memory banks. Streaming data are requested, sent, received, pragmatically discarded, but also constantly cached, stored for the long term, and on this basis analytically exploited. The transmission process produces memory—even if its putatively instantaneous implementation might appear as ›real time‹ in the empirical user's perception. The data that are distributed include distribution data created with every transmission, forming data pools that are ever more expansive and able to be culled with ever increasing sophistication.[205] The associated

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results from various participants, preferably positioned at different geographical places with appropriate language settings, and either from more or less anonymous networks where IP addresses are not tied to individual machines or from the participants' own computers. If browsers from personal computers are used the criteria for the sampling of human participants are an integral part of the setup. This means, among other things, that the researcher has to consider the personal characteristics of the participants, such as age, gender, place of residence, and search habits, when assessing the search results« (Jacob Ørmen, »Historicizing Google Search: A Discussion of the Challenges Related to Archiving Search Results,« in: René König, Miriam Rasch (eds.), *Society of the Query Reader: Reflections on Web Search*, Amsterdam: INC, 2014, 189–202, here: 200).

204 Geographic categories play a role in computer-network-based processes of data distribution not only with regard to the local practicalities of infrastructural systems: where geoblocking is not directly introduced as an instrument of political censorship, IP filtering methods most commonly serve to create a territorial dependency restricting the circulation of data streams and to reinstall the traditional utilization boundaries of national media markets (cf. Ramon Labato, James Meese (eds.), *Geoblocking and Global Video Culture* (Theory On Demand #18), Amsterdam: INC, 2016).

205 The seamless trackability of distribution is nevertheless neither trivial nor completely reliable in terms of media technology. Wendy Chun identifies an obstacle to data tracing: »The traceroute tool sends out a series of packets with increasing TTL (Time to Live)

feedback effects culminate in allowing future data practices to be extrapolated with increasing prognostic precision, in prefiguring them. The transactional transfer data economy counts on this informational model, and this productive, constantly growing volume of data traffic gives rise to the notorious haystacks of secret services.

The agendas of comprehensive data surveillance, verifiable in great detail thanks to the Snowden Archive, the now likewise documented cooperation between commercial and intelligence agents, have also revealed a need to revise conceptions in media theory that read the Internet genealogically from the perspective of the »volatility of data retention.«[206] Furthermore, the dependence on memory—one might also say: memory affinity—of the data stream, as Florian Sprenger has shown, has a fundamental infrastructural, protocol-technical dimension, which is crystallized in the way network nodes operate. Contrary to the idea of a continuously flowing real-time transmission, Sprenger posits a politically interpretable understanding of »micro-decisions,« which break into the data stream at network nodes. »The moment of micro-decisions is the interruption that stops every transmission once more at every node so that the direction and priority of its routing can be decided. Without this decision there is no transmission.«[207] At the network nodes, then, there occurs a »temporary caching by means of fixed protocols,«[208] which in part belongs simply to the technological architecture of the network, to the infrastructural premise of its distributive logic of packet switching. Beyond that, this media-technical mode of controlling the regularity of data distribution also constitutes a gateway for surveillance practices that use the cache time to tap the data stream, as it were, and redirect it into instrumental memory, which for its part operates outside the transmission time.[209] Metadata of distribution

values, starting with one hop. Whenever a packet ›dies,‹ the router at which the packet expires sends a message back to the originating machine; but, since packets can take different routes through the network and since many routers will refuse TTL settings, traceroute offers us a pastiche of packets to map what allegedly has been, is, and will be« (Chun, *Updating to Remain the Same*, 50).

206 Mercedes Bunz has argued in this vein: »The more a data set is repeated at different nodes in the network, the more widespread it is in the network, the more probable is its constant presence. The new medium thus shifts the modus operandi: The availability of data is no longer secured by storing it, but by distributing it. In fact the Internet [...] has not been a storage medium from the very beginning« (Mercedes Bunz, *Vom Speicher zum Verteiler. Die Geschichte des Internet*, Berlin: Kadmos, 2008, 18).

207 Florian Sprenger, *Politik der Mikroentscheidungen: Edward Snowden, Netzneutralität und die Architektur des Internets*, Lüneburg: Meson Press, 2015, 20.

208 Ibid., 19.

209 Cf. ibid., 54ff.

(pending analysis methods: statistical/stochastic packet inspection), but also including the content data (deep packet inspection) of the messages conveyed, are then stored in unsorted, randomly structured, but—at least for statistical or graph-theoretical operations—explorable ›haystacks.‹ If the transfer were truly free of interruption and instantaneous, these data memory banks would not exist in this form. The stream would remain traceless, the traffic without history.

Stream and storage therefore maintain a repeatedly conveyed, functionally differentiated relation of exchange, which can be read in various ways in infrastructures, formats, protocols, volumes, temporalities of data distribution. Sean Cubitt's related hypothesis—»The difference between storage and transmission [...] begins to dissolve in digital media«[210]—perhaps initially sounds like an analytically unsatisfying formula from the terminological environment of theories that see ›convergences‹ and ›metamedia‹ at work everywhere, instead of addressing individual processes in their internal complexity. In Hartmut Winkler's highly sophisticated study of the question of how the two more prominent media functions of Kittler's triad—memory and transmission—appear from the perspective of a heuristically centered media function of processing (»intervening change«), he nonetheless comes to a not entirely dissimilar conclusion:

> In fact transmission operations are in no way free from intervention, insofar as transmission always includes technological transformation, and insofar as the influence of the medium has to be taken into account; and likewise the random noise in the transmission and entropy in the case of memory. My suggestion was to take all this as forms of a self-actuating process that is not intended and springs from media constellations rather than from human subjects that guide the operations. And the particularity of this form of processing was that it is not part of processing, but of storing and transmitting. Systematically, this means that media functions in each case contain embedded particles of other media functions.[211]

In this sense data transmission represents a form of data processing. Data transport can only be understood in relation to processes of transformation that are precisely not external to transmission. With a computer-network-based transfer technology like streaming—in which on the one hand available

210 Cubitt, *Practice of Light*, 235.
211 Winkler, *Prozessieren*, 217.

broadband capacities are processed synchronously with the transmission or adaptively to it, and on the other hand nearly real-time decoding operations are executed that are briefly buffered by means of caches—processes of alteration intervene directly and utterly profoundly at the level of the signal. Even in the activated caches, the streaming product is not »immobilized« but permanently »fluidified.«[212]

This operation can be described, with Martin Warnke, as follows: The transmission product is not saved in the recipient's incoming packet storage, but processed and discarded datagram by datagram, which is registered in the form of returning delivery receipts in the likewise ad hoc exit storage of the sender; these receipts in turn trigger the sending of further data packets and regulate the »structure of the message chain« from the moment of the »welcoming sequence.«[213] The queried web server additionally saves aspects of the packet transfer on the (non-descriptive) metadata layer of a delivered streaming file—for each query, each retweet, each like, one can say: »every move has the potential to count for something, for someone somewhere somehow« (Gitelman)—which likewise involves a change in the media product, resulting in consequences for future distribution. In addition, a video stream, for instance, is in any case not really identical to itself structurally, because the transfer protocols responsible for its distribution specifically allow for elements of the complete data product to be lost in the connection, without there being any interruption in the connection: »Wherever it comes down to performance rather than security, for instance with internet telephony or the transmission of a video, one forgoes this security [of the TCP] and deploys the more unreliable User Data Protocol (UDP). Here a couple of individual data might be missing, but in exchange long interruptions are avoided.«[214] In this respect, in the case of streaming technology we can at best very restrictedly assume a clearly defined sequence schema, according to which it would be the case that »phases of a firmly constituted product identity (memory, transfer) and phases in which this product identity is dissolved (processing) […] [supersede] one another.«[215]

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212 Ibid., 154ff.

213 Warnke, *Theorien des Internet*, 78f.

214 Ibid., 77.

215 Winkler, *Prozessieren*, 153. Winkler consistently works with the sequence schema cited here—even if he refers to the »linked« media functions as a »network« (ibid., 191ff.)—although at one point he does state that the »computer processor […] completely dissolves what is here called processing in the operations of transfer and memory« (ibid., 170).

Given what we have examined thus far, the following interim result can be formulated here: Memory is distributed and distributing, the stream is conveyed through cache memory and constitutes memory. Or to put it more succinctly: Memory becomes transfer memory, transfer is carried out as memory performance. The media-theoretical conceptualizations involved here do not completely dissipate, but are interwoven in such a way that it is ultimately a heuristic question of perspective, of emphasis, whether data traffic and its logistics are to be examined primarily in relation to the permanence and intensity of their distributedness, or rather in relation to the processes—continually running qua ›back channel‹—of storing, of tracking, of the ›prognostic‹ canalization and economization derived from them. If non-volatile memory forms are increasingly construed in relation to distributive functions, to accessibility that is as instantaneous as possible, and at the same time distribution operates like memory and is productive of memory, then, as the next chapter will examine more thoroughly, this particularly concerns the distributed processes of a storage institution, which organizes a specific »transfer along the axis of time«[216]—and is called archive.

216 Ibid., 182.

II

Archive

Media Historiography

II.1 Streaming Archives

Wherever there are streams, memory and storage can be formed. Information flows are stabilized as storage content primarily through protocols that have been formatted bureaucratically since the nineteenth century.[217] These protocols are distributed by an institution: the archive. Nonetheless, not every operation of storage and memory has archival intentions. Only certain techniques and practices of collecting, retaining, and holding ready are, strictly speaking, associated with any effective intention—at least as a background concern—to preserve materials and pass them on, the institutional expression of which are archival facilities. The persistence of archived material ensured by storage media—the implicit long-term guarantee that transfer into the archival space will, generally speaking, relieve a selected object of both the temporally induced effects of corrosion as well as unauthorized access—is thus joined with an archival agenda that is socio-culturally more or less explicit. While not every act of storage can be addressed archivally, the reverse is true: every archive can be traced back to its media-technical storage design—without, however, being completely determined by it.

Archives usually have identifiable sponsors and distinct supporting and administrative media. In their interplay—governed by the formalities of inventory and distribution—they formulate concretely developed archival politics. The processes realized in this formulation sometimes determine, in great detail, which materials are to be included in the institution and which will remain excluded, how (deeply) the organization of the archive—for instance, in the form of the classifications also archived there[218]—is inscribed in the emergence of the stored material, and under which conditions it can then circulate, be publicly visible, be made available for consultation: »In the archive the stored materials, the organizational principles, and the media that they register, are so intertwined that they cannot be disconnected from one another.«[219]

When processes and agents of storage are transformed, it is plausible to assume that the media-technological alterations responsible for this transformation have a decisive influence on which objects, which data

217 Cf. Sven Spieker, »Einleitung. Die Ver-Ortung des Archivs,« in: Spieker (ed.), *Bürokratische Leidenschaften*, Berlin: Kadmos, 2004, 7–28.

218 See the foundational text: Geoffrey C. Bowker, Susan Leigh Star, *Sorting Things Out: Classification and Its Consequences*, Cambridge, MA: MIT Press, 1999.

219 Spieker, »Die Ver-Ortung des Archivs,« 18.

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configurations are fundamentally worth considering as archival materials, and through which modes of protective storage, of taxonomical incorporation and of regulated release these materials can be integrated as archival documents—which can also always be designated as documents of an archival arrangement transmitted by inscription, and regarded accordingly. In other words: which media contents are checked into the archive and at what rates they can be—selectively and temporarily—checked out, how the procedures of registration relate to those of acquisition and cassation, is essentially dependent on distributive versatility, on the distribution processes and potential of the storage media involved. Archives take discrete sections of reality out of present circulation, setting up instead new channels and transport media, by which these stored materials are meant to remain accessible in the future. Archival techniques of preservation, of distribution in storing and releasing objects work together in the model of an agency of remembrance based on fundamental accessibility and marketability.

Media infrastructures and discursive conjunctures of archives are manifestly likewise interconnected. If architectures are transformed, and in the process the cultural technologies of the archive are transformed as well, this also alters the circulation of archival holdings along with any concurrent archival semantics—such as a mnemonic configuration. As outlined in the previous chapter, a terminological consequence of what can be regarded on several levels as the excessive storage productivity of digital data distribution—including its »increasing traceability« (Latour)—is that once again the concept of the archive is forced to expand its borders. On the one hand, we observe an evident and everyday proliferation of collections of images, texts, and data (including a number of »humble archives,«[220] in terms of their genealogy), which not only, according to the rate of increasing complexity in circuits predicted by Moore's law, can always be achieved more comprehensively and cost-effectively, but can also be ever more effortlessly networked, distributed further, copied—a dynamic of extension that, with the transcoding pragmatics of digital

220 Alf Lüdtke uses this expression to refer to various forms of private, non-state collection practices, which since the 1970s have successively liberated the term »archive« from its »official, arcane sphere«: »It is not a matter of ›registered written materials‹ of this or that ›course of business.‹ Rather, they want to archive previously ignored text types or non-textual materials, and thus above all *to facilitate their publication.* [...] These activities draw on a universe of real, existing archives held by individuals or in households—often they are ›humble‹ archives of correspondence or notes, tucked away in attics or in cellars, in suitcases, boxes, or crates« (Alf Lüdtke, »Archive—und Sinnlichkeit? Nachgedanken zu Arlette Farges ›Der Geschmack des Archivs,‹« in: Arlette Farge, *Der Geschmack des Archivs*, Göttingen: Wallstein, 2011, 99–116, here: 107).

representation, can also be transferred ever deeper into analog holdings. Data is being stored more frequently and more incidentally (often also secretly and unwittingly), while at the same time we can observe comprehensive processes of conversion in storage transfer. ›Native‹ digital and digitized files flow into the same depots (such as the databases of social media providers), are channeled, processed, and (temporarily) stored by the same protocols, programs, and platforms. On the other hand, parallel to the spread of digital data, media and cultural studies have worked toward universalizing the concept of the archive as a dominant cultural metaphor and generalizable epistemic figure of interpretation, which in the meantime has resulted in complaints about the »inflation of the archival« and concomitant losses in terminological precision—not least with regard to related agencies of memory like museums[221] or libraries.[222]

The increased scope and dynamic of the term ›archive,‹ however, might lead to permanently risking the concept's devaluation only if the diagnosis of the erosive forces causing such devaluation remains underdetermined. The focus here is on the question of the implications of the much-touted ubiquity of digital data storage, insofar as they are relevant to archival theory—or more precisely: the question of its operability as the media technology of the archive. What is the basis for the assumed authority of the concept of the archive, and what are its limits? What are the processes that move this concept into »streaming« or set it »in motion« in the first place? As Eivind Røssaak puts it: »The archive itself is [...] no longer easy to archive, that is, it is no longer easy to control the concept, to store it, to stop it, to arrest it, and safely guard its meaning or origin from slippery semiosis. We can no longer shelter it from the flow of meanings and uses it is constantly getting involved in. Reflections

221 Cf. Oliver Grau (ed.), *Museum and Archive on the Move: Changing Cultural Institutions in the Digital Era*, Berlin: de Gruyter, 2017.

222 Knut Ebeling, Stephan Günzel, introduction to *Archivologie. Theorien des Archivs in Philosophie, Medien und Künsten*, Berlin: Kadmos, 2009, 7–26, here: 7. In terms of the history of theory, from the perspective of media and cultural studies the inflating of the archive, which continues to this day, begins with the power-critical ›de-institutionalization‹ of the term in the context of Foucault's research on the archaeology of knowledge: »I shall call an *archive*, not the totality of texts that have been preserved by a civilization or the set of traces that could be salvaged from its downfall, but the series of rules which determine in a culture the appearance and disappearance of statements, their retention and their destruction, their paradoxical existence as *events* and *things*« (Michel Foucault, »On the Archaeology of the Sciences: Response to the Epistemology Circle« [1968], in: James D. Faubion (ed.), *Aesthetics, Method, and Epistemology: Essential Works of Foucault, 1954–1984*, New York: New Press, 1998, 297–334, here: 309).

on the archive today cannot seek the security of a shelter, of an archive; it has to walk out, get moving.«[223]

The following discussion—as an introduction to material examinations of selected image archive holdings with their own specific institutional agendas: the NYC Department of Records (II.2) and the United States Holocaust Memorial Museum (II.3)—will outline what it might mean to understand digital archives (with retro-digitized archival records and remote access) in media-logistical terms in the sense argued here, namely as streaming, (temporarily) stored, computer calculable data depots.

This will not be a matter of tracing the discursive ramifications of, or constructing a conceptually updated refuge for the »archival turn«.[224] Rather, my interest here is: Which distribution calculations work in and about archival configurations that are concretely »in motion« insofar as they are operated in the media technologies of streaming, of ›real-time‹ instantaneous distributability? How do these archives, which are charged with special transport orders, calculate their contents? And what do the stream-like aggregate states of networked documents deposited in this way in turn mean for the distributed image, which is the focus here? What ›histories,‹ what media historiographies has it stored, how do new archival codes get inscribed and old ones rewritten? What genealogy of distribution technology does the data stream transport into the present of digital access to material?

The last section of this introductory chapter, which makes a general argument in terms of archival theory largely without specific reference to the image, is meant to open up a media-historiographic perspective in preparation for such questions. In subsequent steps—under the headings Long-Distance Photographs (II.2) and High-Frequency Videos (II.3)—this perspective will shine a media-archaeological light on distributive constellations, which are also archived to a certain degree, particles in the general data stream. As noted at the outset of this study: The image did not first become technologically distributable when it acquired the capacity to be calculated and transported by computer network protocols. The histories that become specifically distributable in the digital image can also be further interrogated for the media histories of technological image distribution that they distribute and thus carry forward into the present.

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223 Eivind Røssaak, »The Archive in Motion: An Introduction,« in: *The Archive in Motion: New Conceptions of the Archive in Contemporary Thought and New Media Practices*, Oslo: Novus Press, 2010, 11–26, here: 15.

224 Cf. Valeska Bührer, Stephanie Sarah Lauke, »Archivarische Praktiken in Kunst und Wissenschaft. Eine Einführung,« in: Valeska Bührer, Stephanie Sarah Lauke, and Peter Bexte (eds.), *An den Grenzen der Archive*, Berlin: Kadmos, 2016, 9–21.

II.1.1 Transmission and Temporary Storage

In terms of distribution, as should already be clear, the operation of streaming archives is not in any way unregulated and ephemeral, but predictable and trackable in great detail, down to their microtemporal processes. Every datagram, every transport operation has a signature, leaves a trace, which can be verified and used for calculations. In the expanding discussions about digital archives in media theory there are various approaches—which in the final analysis are positioned in entirely similar ways—to conceptually grasping the computational archive dynamics between stream and storage, between data flow, data feedback, and data sedimentation. In Adrian Mackenzie's reflections on the substructure of temporal dynamics in current »information networks« the archive operates as an almost oppositional movement—as a »drive,« which works against the (assumed) permanent presentness of real-time computation, thus bringing together different models of storage management:

> The ever growing totality of inscriptions that weave the text of the Internet networks, with its mass storage and data warehousing systems, are the product of the archive drive. While real-time produces the temporal ›here and now‹ of virtual culture, the archive drive produces a locational ›there‹ composed of texts, images, indexes and records. [...] Examples are: (i) the movement of existing printed and recorded texts into the space of the electronic archives: everyone from Bill Gates to the Louvre is involved in that translation; (ii) the business of ›data-mining‹ that is increasingly the backbone of corporate profitability in an increasingly real-time market through processing and modelling the archives or ›data-warehouses‹ of previous transactions.[225]

The increasingly full data depots of distribution therefore react, at least indirectly, to the finite signal transit times of transport packages, which are given a concrete ›lifetime‹ with every distribution operation on their way through the computer networks—a lifetime that is called exactly that: »Time to live« (TTL) tells a data packet in the header how much time it has to reach its goal. In this sense, the protocols responsible for the transfer contain bad news for the information concerned, namely deadlines (the counter variable is called »hops« and refers to computer relay stations, to the passage between network intersections). For Mackenzie the archive drive processes this specific mortality—»that

225 Mackenzie, »The Mortality of the Virtual,« 61.

no information can live in the networks forever«[226]—by regarding the circulation data themselves as storage contents. The archive drive compensates for the ›death‹ of data that occurs in the timeliness of the transfer with deposited transfer and transaction data storage, which can also be commodified according to the requirements of real-time analytics tools—that is, ›in real time.‹

Independently of this, the data holdings of the archive are augmented by a collection of archive usage metadata, which in turn, processed accordingly, has a profound reflexive effect on the collection. David Berry speaks here of the »second-order archive« and »computational rationalities,« which the archives ›cybernetize,‹ so to speak, in that feedback logics are able to control what can be collected and how it can be recorded, searched for, and found: »[…] this reflexive database (metadata) of the archive's use and motion can be used to fine-tune, curate, and prune the archive algorithmically.«[227]

According to the model of this description, the process of archive consultation—at every step along the way: from the initial request and the concrete transport modalities to the successful delivery and receipt of the archival material by the user—is permanently integrated into the calculation of the archive drive. Mackenzie is not alone in observing that its operational mode derives from the processor-memory gap of the von Neumann architecture.[228] Robert Gehl also sees real-time drive and archive drive, the two fundamental network dynamics, as inferable from the relationship between the central processing unit (CPU) and various working and temporary memory modes (where so-called arithmetic registers operate within the processor core, at the top of the memory hierarchy). According to Gehl, they are based on »the development of the modern computer itself, which is a synthesis of the immediate

226 Ibid., 59.

227 David M. Berry, »The Post-Archival Constellation: The Archive under the Technical Conditions of Computational Media,« in: Ina Blom, Trond Lundemo, Eivind Røssaak (eds.), *Memory in Motion: Archives, Technology, and the Social*, Amsterdam: Amsterdam University Press, 2017, 103–125, here: 106. Ina Blom writes in the introduction to that volume: »[…] once the archive is based on networked data circulation, its emphatic form dissolves into the coding and protocol layer, into electronic circuits or data flow. Archival data have, of course, always been in circulation: the whole point of an archive is to allow documents to be mobilized for the shifting needs and inquiries of the present. But with the networked digital archive, this circulation becomes a feedback circuit whose material structure is that of vectorial dynamics and electromagnetic fields« (Ina Blom, »Introduction: Rethinking Social Memory: Archives, Technology, and the Social,« in: ibid., 11–40, here: 12).

228 Mackenzie, »The Mortality of the Virtual,« 62. On the computer historiographic arrangement of von Neumann architecture, cf. Thomas Haigh, »Von-Neumann-Architektur, Speicherprogrammierung und modernes Code-Paradigma,« *Zeitschrift für Medienwissenschaft* 12 (2015), 127–139.

(in the form of the CPU or processor) and the archival (in the form of memory and storage of data).«[229] This dichotomy is indeed understood conceptually as absolute, but it ultimately describes a division of labor, because the command cycle (fetch-execute) is configured cooperatively. Under computer network conditions this logic extends further to the distributed memory—which also draws on the data productivity and connectivity of the end user device[230]—provided that new connections between (combined) processor performance and (distributed) data resources are possible:

> Memory capacity has grown tremendously, leading to today's terabyte drives that store vast amounts of information. This information must be routed to the processor. To do so, computer architects have developed busses, short-term caches of memory, and dedicated pathways for instructions and data in order to link them. Thus, we have a basic architecture: processor, memory, and the path between the two. Computer engineers seek to optimize the relationship between memory and the processor to create an ideal synthesis of the immediate and the archival. In Web 2.0, the path between the user/processor and the archive is the broadband Internet connection.[231]

If one follows this argument, all the information flows of networked computers—even those that transfer archival data in the narrower, more institutional sense—are based on the operational logic of temporary memory. In terms of archive theory, this opens up a theoretical problem of memory at the level of the temporal horizon that is invoked, more precisely, between memory and storage,[232] because the fact that data is shifted out of time for the short-term during data processing seems hardly compatible with the storage ideals, guided by persistence and duration, of conventional concepts of the archive.

In his work on archival and memory theory, Wolfgang Ernst also assumes that the transient storage processes that take place on the CPU of the digital computer represent the inescapable starting point in media theory for any understanding of the wide variety of computer network technological

229 Robert Gehl, »The Archive and the Processor: The Internal Logic of Web 2.0,« *New Media & Society* 13 (2011), 1228–1244, here: 1229.

230 Gehl speaks here of »affective processing« and ultimately formulates a critique of the centralizing and economic absorption of the »archives of affect« that are stored in this process (cf. ibid., 1240).

231 Ibid., 1238.

232 Cf. Wendy Hui Kyong Chun, »The Enduring Ephemeral, or the Future Is a Memory,« *Critical Inquiry* 35 (Autumn 2008), 148–171.

intensifications and ramifications of the »post-archival constellation.«[233] In Ernst's *Das Gesetz des Gedächtnisses* [The Law of Memory], which was published a good ten years ago, the data transfer operation of streaming figures prominently in the final chapter as a comparatively new web-based media technology, still struggling with broadband limitations. According to Ernst, however, it is nonetheless paradigmatic of a development to which his entire book is dedicated, namely the substitution and reinterpretation of classic archival storage processes by processes wired for permanently temporary storage and transfer.

The technological operativity of memory that thus becomes dominant begins to transform all archival processes, replacing long-term, document-stable storage with the performative principle of instantaneous regeneration on demand, replacing one-time safeguarding with the necessity of responding to digital obsolescence with routines of continual data migration and archives of backward compatibility that are capable of emulation.[234] Where there were once archive buildings, now there are increasingly relational data banks in operation, linear numbered shelved are replaced with complex tabular keys and URL addresses, topographical localizability with comprehensive dynamics of temporalization. Where a temporal immobilization of the time of a stored document was once associated with a »transfer along the axis of time« (Winkler), there now dominates a logic of regeneration and updating, of update and refresh cycles, that is, the switchable real time of an incessantly present transfer of aggregate data:

> In essence, it is the case for streaming media (for instance, RealAudio) that signals are not first completely loaded into storage in order to then

233 Berry, »The Post-Archival Constellation.« Michael Moss sees the current transformation processes more as a return to the archival model of the 18th century, the *Wunderkammer*: »… the potential of the archive and what then becomes archivable on the most powerful distribution channel the world has ever seen is not the harbinger of a post-archival universe, but rather returns curation to its roots in the *wunderkammer* of Enlightenment Europe where everything can appear to be simultaneously disconnected and connected« (Michael Moss, »Memory Institutions, the Archive and Digital Disruption?,« in: Andrew Hoskins (ed.), *Digital Memory Studies: Media Pasts in Transition*, London: Routledge, 2017, 253–279, here: 264).

234 Cf. Jeffrey Rothenberg, *Using Emulation to Preserve Digital Documents*, The Hague: RAND-Europe/Koninklijke Bibliotheek, 2000, and Matthew Fuller, Andrew Goffey, Adrian Mackenzie, Richard Mills, Stuart Sharples, »Big Diff, Granularity, Incoherence, and Production in the Github Software Repository,« in: Ina Blom, Trond Lundemo, Eivind Røssaak (eds.), *Memory in Motion: Archives, Technology, and the Social*, Amsterdam: Amsterdam University Press, 2017, 87–102.

> be heard, seen, or computed, but rather a constant flow of compressed data packets between sender and receiver is maintained so that temporary archives are nested in the act of transfer itself […]. The fact that spatially defined archives are being converted to temporary archives results in the streaming archive. In place of the resident emphatic storage comes dynamic temporary storage, the transfer channel itself becomes an ›archive of time,‹ a dynamic archive.[235]

As a media technology of continuous temporary storage—which is also located, for instance, in the browser cache (and from there can be redirected to the hard drive memory and ›stabilized‹ as a file by means of download managers like ClipGrab)—the data distribution model of streaming, according to this argument, only continues what is already established in the data processing routines of the processor: transient storage or »technomathematical copying«[236] of temporary results, dominance of transfer functions, dynamic-temporalized storage performance.

II.1.2 Depots

The fact that such distributed streaming data are nonetheless situated in a relatively fixed state on a server is consequently less significant than the circumstance that, by definition, they are continuously waiting there for querying clients, waiting to be transported and for data feedback to be triggered. From this perspective, even on the server side—beyond the half-life problematic of digital storage related to the carrier media[237]—the data in question are less

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235 Wolfgang Ernst, *Das Gesetz des Gedächtnisses. Medien und Archive am Ende des 20. Jahrhunderts*, Berlin: Kadmos, 2007, 313. See also Ernst, »Jenseits der AV-Archive—Optionen der Streaming Media,« in: Verein für Medieninformation und Mediendokumentation (ed.), *Fokus Medienarchiv. Reden/Realitäten/Visionen. 1999 bis 2009*, Münster: LIT Verlag, 2010, 81–100. For a critique of Ernst's conceptualization with regard to dynamic processes of temporalization in ›paper-based‹ archives, cf. Moss, »Memory Institutions,« 257.

236 Ernst, »Zwischen(-)Speichern,« 87.

237 This is especially the case for digital archival objects with no analog equivalent. Cf. Annet Dekker (ed.), *Archive 2020—Sustainable Archiving of Born-Digital Cultural Content*, Virtueel Platform 2010. In the context of the PEVIAR Project (Persistent Visual Archive), Rudolf Gschwind, the director of the Imaging & Media Lab in Basel, has attempted to work out the degree to which analog material can be utilized for long-term archiving of digital or digitized information: »A permanent medium that is very familiar is photographic film, microfilm, which has a high data density; this could be a commercial consideration. Films today exposed to rapid aging tests show that they can last a few hundred

archived than they are deposited, that is, stored in a way that is initially conceived more in terms of constant deliverability than permanent preservation.

In short, archives are typically permanent repositories, whereas depots are distribution centers. Their functionality essentially derives from their logistical position within a transport chain. Rather than closed horizons, this is a matter of determining relationships. This is why the terminology of storage logistics ascribes to the depot a bridging function, whose primary purpose is to maintain a constant level, not of material, but of material flows. Stability requirements do exist, but they accordingly relate not to establishing and preserving inventory long-term, but to maintaining a productive circulation, a consistent movement that regularly runs through the depot, although it is not stopped there, but merely regulated via feedback signals. The focus is therefore on rates of flow, stream volumes, issues of transmission. Insofar as archival processes are associated with stopping time, the question arises as to how much they can still be achieved, if at all, on the basis of the process and access times outlined above, which necessarily go hand in hand with the mobilization, the flow management of digital data from the CPU to migration and update cycles.

Anyone wishing to use the term »archive« under these conditions will at any rate have to adapt it to the technical conditions of the media and will need to consider the transfer costs. If »streaming archives« is to be more than simply an oxymoron, there must be some reflection on what archival concepts, what initiatives of archival action can be implemented on the basis of digital data depots. At what levels are the modifications effective, where do they come up against the limits of an operativity of media technology that, at least at the level of »data storage becoming time-sensitive,«[238] initially seems to be arranged in a way that is ›anti-archival‹?

Martin Warnke, with good reason, shares Wolfgang Ernst's reservations about applying the term »archive«—which tends to be understood as

years. This is as good as permanent. For us it is interesting that it is possible to mix information in hybrid forms on a visual medium. On microfilm, digital information can be stored in the form of dot patterns, in a two-dimensional barcode, the highest density type of storage, as well as simple text and image. And even the description of how to read what the digital data means« (Rudolf Gschwind, Lukas Rosenthaler, Ute Holl, »Migration der Daten, Analyse der Bilder, persistente Archive,« *Zeitschrift für Medienwissenschaft* Nr. 2 (2010), 103–111, here: 104).

238 Ernst, »Zwischen(-)Speichern,« 89.

dedifferentiatedly mnemosematic, but is ultimately often purely metaphorical[239]—to the already difficult-to-define (in part because it is topologically distributed[240]) ›totality‹ of the Internet. Inasmuch as it tends, due to its basic network infrastructure, toward permanent self-overwriting, toward processual currency and presentness—that is, in many essential respects it consists of a coupling of transient packet shipments and dynamic, on-demand generations of connection, which, for their part, as in search engine results, are not only not archivable by the user, but are not even self-identically reproducible at any given later point in time[241]—a dissolution of archival logics into flexible transfer processes and constantly renewing acts of communication seems somewhat evident. Where there was once the archive, there now operate archival calculations, which have long since transcended formerly established institutional boundaries.[242]

Warnke considers it crucial to not pin down the archive wholly in terms of space and structure, but instead to locate it fundamentally in terms of interconnected activities and horizons of updating:

> The internet is obviously a mixture of pure transport and temporary storage, which for data packets never lasts more than a few seconds. The question of the lifespan of Internet documents thus depends on the end device: the transmission packets disappear on their own. What is no longer on

239 Cf. Andreas Bernard, »Das totale Archiv,« *Merkur. Deutsche Zeitschrift für europäisches Denken* 801 (2/2016), 5–16.

240 The fact that, from the viewpoint of network typology, the Internet is distributed (that is, not simply decentralized), has been examined from a critical »protocollogical« perspective: Alexander R. Galloway, Eugene Thacker, »Protokoll, Kontrolle, Netzwerke,« in: Ramón Reichert (ed.), *Big Data. Analysen zum digitalen Wandel von Wissen, Macht und Ökonomie*, Bielefeld: Transcript, 2014, 289–311.

241 According to Jacob Ørmen, the main problem with understanding search engine results themselves as archivable online documents is that they are the result of a cooperation between the search query and the search engine service—»They simply don't exist prior to the particular act of searching« (Ørmen, »Historicizing Google Search,« 191). The logic of continuous indexing (search engines, like libraries, have access to continuously updated catalogues; both can give specific answers to specific queries because they have access to unrivaled information about the total inventory) also involves algorithmic parameters that produce non-simultaneities such as personalization and localization of the search query.

242 In a certain sense, the temporalization of streaming archives also already applied within the walls of classic archives. In this sense we can understand, for instance, histories of knowledge of the archive that argue from a praxeological-social theory perspective, going beyond concepts of passive memory to argue against a positivism of written texts, catalogues, inventories; cf. Markus Friedrich, *Die Geburt des Archivs. Eine Wissensgeschichte*, Berlin: De Gruyter, 2013.

> the server can no longer be reached, and the notorious ›Error 404, document not found‹ appears instead. The Internet itself is thus obviously unsuitable as an archive. […] Archives, especially digital ones, only last when they are constantly being used, when a preserving entity continually re-codifies, re-interprets, and re-evaluates them, actively acquiring their documents, publishing or concealing them, thereby enabling and structuring knowledge, provoking or seeking to suppress actions. Only in this way do digital archives survive the decades.[243]

The insight that it would be terminologically misdirected to describe the Internet in toto as an archive—because all that can be identified, even on the level of transfer protocols, are structures of limited duration and relative stability[244]—does not imply that web-based archival processes are conceptually unimaginable. It is uncontested, however, that a conversion takes place, which Wendy Chun calls »dynamic preservation«: »[…] to ›store‹ something digitally, one often destroys what actually exists […] when ›saving‹ a file, one writes over an existing one. […] To access repeatedly is to preserve through construction (and sometimes destruction).«[245]

Under digital conditions, practices of saving can have to do with copying, overwriting, regenerating, and above all with distribution.[246] Locking away the originals does not have conservational value here, in the sense of the probability of future availability of storage memory; rather, this purpose is served by strategies of maximizing distribution. The more distributed the storage, the safer it is—this formula, which is initially counterintuitive from a traditional archival perspective, is made plausible at least by the persistent effects

243 Martin Warnke, »Digitale Archive,« in: Hedwig Pompe, Leander Scholz (eds.), *Archivprozesse. Die Kommunikation von Aufbewahrung*, Cologne: Dumont, 2002, 269–281, here: 272, 280.

244 Daniel Rosenberg rightly points out how eminently important archival agendas were that were implemented precisely on this level: »In electronic space, objects once traditionally thought of as documents mingle, disintegrate, and recombine according to protean systems and rules. For understanding recent history, these systems and rules are themselves objects of great archival importance, though their traces are not often intentionally conserved. Figuring out how to archive this archive is no small matter. It will be the foundation for the history of the epistemology of our contemporary era« (Daniel Rosenberg, »An Archive of Words,« in: Lorraine Daston (ed.), *Science in the Archive: Pasts, Presents, Futures*, Chicago: University of Chicago Press, 2017, 271–310, here: 272).

245 Chun, *Updating to Remain the Same*, 52, 90.

246 On the specific adaption and stability effects of non-hierarchical forms of organizing networks, cf. Hartmut Böhme, »Netzwerke. Zur Theorie und Geschichte einer Konstruktion. Einführung,« in: Böhme, Jürgen Barkhoff, Jeanne Riou (eds.), *Netzwerke. Eine Kulturgeschichte der Moderne*, Köln: Böhlau, 2004, 17–36, here: 23.

of certain data collections, which have been discussed as »already distributed archives«[247] (Sebastian Lütgert) and are organized through collaborative file-sharing protocols such as BitTorrent trackers:

> The astonishingly resilient archiving practices around […] the Pirate Bay, and the even more virulent promise of actual or imaginary archives far beneath or beyond them—if, for one moment, we could step outside the age of copyright we all inhabit, and fully embrace the means of digital reproduction most of us have at our disposal—not just directly follow the trajectory traced by Benjamin and Langlois, but extend it to a point in the not-so-distant future where we will think of archiving primarily as the outward movement of distributing things: to create ad-hoc networks with mobile cores and dense peripheries, to trade our master copies for a myriad of offsite backups, and to practically abandon the technically obsolete dichotomy of providers and consumers. The model of this type of archive, its philosophical concept, would be the virus, or the parasite. And again, this model also allows us to make a tentative assessment of the risks and dangers of outward archiving: failure to infect (attention deficit), slowdown of mutation (institutionalization), spread of antibiotics (rights management), death of the host (collapse of capitalism).[248]

247 Quoted in Guido Kirsten, Florian Krautkrämer, Sebastian Lütgert, »Piraterie als filmpolitische Praxis. Sebastian Lütgert im Gespräch mit Florian Krautkrämer und Guido Kirsten,« *montage AV. Zeitschrift für Theorie und Geschichte audiovisueller Kommunikation. Streams and Torrents* 26/1 (2017), 81–90, here: 87.

248 Jan Gerber, Sebastian Lütgert, »10 Theses on the Archive,« Pad.ma, 2010. A distributed filesharing collection like the cinephile platform that operates as an invite-only tracker under the alias »Schwarzer Rabe« [»Black Raven«] could unquestionably be discussed as a digital film archive (not least because of the shared curatorial care and systematics practiced there). In their manifesto, however, they prefer the library as a memory agency model: »[Schwarzer Rabe] strives to be more than just a regular BitTorrent tracker for movies. We are an exclusive private filesharing community focused on creating a comprehensive library of Arthouse, Cult, Classic, Experimental and rare movies from all over the world.« The lending function of the library that is expressly emphasized here, however, is ›archivally‹ safeguarded by a reseed function, which entails quasi-institutional consolidating effects, as the range, variety, and lifespan of the audiovisual data holdings that can be consulted through Schwarzer Rabe have attested to for more than ten years: »Unfortunately one of the big disadvantages of the BitTorrent p2p system is that most torrent swarms die off relatively quickly, mostly because people do not have any incentive to keep torrents seeded. Other trackers would just delete those dead torrents. We on the other hand have set out to change that. In general, we do not delete any movie torrents and we do not consider old torrents to be ›dead‹. They are just unseeded at the moment. If a torrent has been unseeded for two days with no activity, a big red button on the top of the torrent details page allows you to request a reseed for the torrent. […]

Even beyond these »viral« archival dynamics[249]—which are based on the duplication of digital copies by means of distributed data references, and thus also on distributed depositing of data in ›mirror‹ archives—it is the case that while the Internet may well be unarchivable and not an archive in itself, it does distribute archival agendas, practices, and holdings. These connections and operations, or more precisely: these institutionally bound material collections, their distributed contents, interfaces, and infrastructures, will be examined in the following chapters, which are intended to develop more concrete readings of digital image archives

II.1.3 Transmitting the Institutional

The heuristic restriction to institutional archival agendas and intentions that has been chosen here is justified in part by the multifaceted empiricism of a conjuncture that can be observed beyond the filesharing practices that show an affinity to archives. More and more traditional archival facilities are transcoding their reservoirs, establishing platforms, entering into social media forms of communication—generally speaking, they are organizing themselves through a hybrid combination of online and offline processes, integrating digital operations on a wide variety of levels into their institutional architecture and practice. The implications of the »connective turn« (Andrew Hoskins)[250] concern

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The combination of reseed requests and the various bonuses have created an extremely effective mechanism that allows even long-dead torrents to be resurrected swiftly. You can put in a reseed request and usually find the torrent seeded the next day« ([Schwarzer Rabe Homepage], last edited Feb. 20, 2007). Cf. Guido Kirsten, Fabian Schmidt, »Von Schwarzen Raben und anderen Netzwerken. Filmdistribution in der Schattenwelt des Internets—ein Bericht,« *montage AV. Zeitschrift für Theorie und Geschichte audiovisueller Kommunikation. Streams und Torrents* 26/1 (2017), 59–80; Ekkehard Knörer, »Movable Images on Portable Devices,« in: Gertrud Koch, Volker Pantenburg, Simon Rothöhler (eds.), *Screen Dynamics: Mapping the Borders of Cinema*, Vienna: Synema, 2012, 169–178, and more generally Tilmann Baumgärtel (ed.), *An International Reader in Media Piracy: Pirate Essays*, Chicago: Chicago University Press, 2016, as well as Theo Hug, Ronald Maier, Felix Stalder, Wolfgang Sützl (eds.), *Medien — Wissen — Bildung. Kulturen und Ethiken des Teilens*, Innsbruck: Innsbruck University Press, 2012.

249 Cf. Jussi Parikka, *Digital Contagions: A Media Archaeology of Computer Viruses*, Bern: Peter Lang Publishing, 2007.

250 Hoskins offers a perspective on this »turn« as the transformational narrative of memory studies, while at the same time pointing out the limits of the »post-scarcity culture« that has arisen: »The triumph of the networked archive to deliver an apparently anytime, everywhere view, paradoxically illuminates the infinity of media after the connective turn, and thus the limits of our capacity to hold or to store (a classical problem of memory),

archival materials as much as archival structures, which are likewise included in and thus reformulated by digitization processes. The result is novel archival objects and archival operations that intervene in different ways. Archives now routinely deal with digital holdings, while databases have become important archival agents (equipped with a significantly expanded agency in comparison to analog lists, catalogs, registers), without interrupting continuities at the level of archival practice.[251]

In this context—against the backdrop of a correlative determination of storage memory and functional memory—Aleida Assmann has spoken of a complementarity:

> In the institutions of the archive respectively the Internet, two complementary memory operations can be differentiated, which relate to one other as do ›saving‹ and ›retrieving‹: the archive fulfills the desire for reliable material conservation and long-term safeguarding of information, the Internet fulfills the desire for speeding up the flow of data and immediate access to information. Both institutions are essentially based on the new technologies of digitization, but they differ in turn in the use that they make of these technologies. In the archive they serve to safeguard and preserve data, in the Internet they facilitate an acceleration of the flow of information and the increase in acts of communication.[252]

as well as to know« (Andrew Hoskins, »Introduction to Digital Memory and Media,« in: Hoskins (ed.), *Digital Memory Studies: Media Past in Transition*, London: Routledge, 2017, 1–24, here: 3).

251 »Without continuity of practices, the archive would not just slumber from time to time; it would sink into a coma. Stable practices of collecting, selecting, canonizing, scrubbing, and ordering data insure that the contents of archives are commensurable and retrievable« (Lorraine Daston, »Epilogue: The Time of the Archive,« in: Daston (ed.), *Science in the Archive: Pasts, Presents, Futures*, Chicago: University of Chicago Press, 2017, 329–332, here: 331).

252 Aleida Assmann, »Archive im Wandel der Mediengeschichte,« in: Knut Ebeling, Stephan Günzel (eds.), *Archivologie. Theorien des Archivs in Philosophie, Medien und Künsten*, Berlin: Kadmos, 2009, 165–175, here: 174. According to Assmann, storage and functional memory only diverge in the moment of developing efficient external storage media (for her, writing is the first such medium), which function as a »memory replacement,« and thus can also preserve currently ›functionless‹ knowledge that can then be transferred from the storage memory into the functional memory at a later time. In this sense, archives are paradigmatic institutions of storage memory, but they maintain a relatively direct data flow (in historical terms, facilitated primarily by the nation-state since the 19th century) to the agents of functional memory (ibid., 169ff.).

Referring to the Internet as an »institution« seems somewhat questionable—however, the pragmatics this designation describes are plausible, namely a division of labor that had already led to an »unrestricting«[253] of the archive by information technologies, to other modes and ranges of access. But the fact that, from the perspective of media technology, this division of labor might be better described with the aid of a re-entry figure—to the extent that digital processes of retrieval are always operationalized by a relay between search requests and (temporary) storage, and furthermore that under the conditions of computer network protocols the request itself can also (potentially for the long term) become the stored content (initially, for instance, in the form of IP addresses automatically registered in a database)—already suggests that the concern must be with relating the new archival practices (regarding storage, safeguarding, classification, and also consultation) to the performativity of the storage media under discussion here. Particularly if it is true that, wherever storage units change, institutional ideas of »archivability«[254] must also undergo a transformation. This is the case, for instance, for data material that cannot be stored anywhere in analog form because it was generated (or ›born‹[255]) digitally from the outset and now becomes an object of archival ›desire,‹ which is already conceived extensively and strives »to transform ever larger areas of the world into an archive by means of external storage, independent of the subject.«[256]

If more and more communicative practices and information objects are constituted digitally, thereby becoming ever larger »content streams,« from the perspective of the archive this creates problems of selection related to storage technology and normative questions on the one hand, while on the other hand it is also apparent that legitimate archival mandates arise in the digital realm—whether this concerns the Twitter account of a US president

253 Ibid., 174.

254 »Everything that the work of culture has produced until now, especially the documents of culture as such (literary and artistic texts) is to be placed within the linked file and directory structures of the electronic archive. In addition, the archive drive conceives of ever new projects on the basis of their archivability. These are not projects for use, consumption or circulation elsewhere and then preserved in the electronic archive, rather they are generated by the referencing and storage structures of the network themselves« (Mackenzie, »The Mortality of the Virtual,« 61).

255 Which requires a new »forensics«: cf. Matthew G. Kirschenbaum, Richard Ovenden, Gabriela Redwine, *Digital Forensics and Born-Digital Content in Cultural Heritage Collections*, Washington, D.C.: Council on Library and Information Resources, 2010.

256 Jürgen Fohrmann, »›Archivprozesse‹ oder Über den Umgang mit der Erforschung von ›Archiv‹. Einleitung,« in: Hedwig Pompe, Leander Scholz (eds.), *Archivprozesse: Die Kommunikation von Aufbewahrung*, Cologne: Dumont, 2002, 19–23, here: 19.

or the more ordinary digital routines of official document management, which continue to produce »paper knowledge,«[257] no longer in the form of paper, but rather as records management in data files: the »immeasurably increased data processing power at the end of the era of paper documents.«[258]

In any case, the increasing digitization of »areas of the world« that are fundamentally of archival value is carried out against the backdrop of distributed memory networks. For Sven Spieker, the concomitant spatial diffusion of the archive entails its dissolution into environmental knowledge expedited by information technology:

> As locations, archives have always depended on the rigorous distinction between (their own) inside and its outside. [...] The archive today functions less as an inside defining itself against what surrounds it than as an environment without outside where what is archive and what is not is increasingly difficult to tell. We do not »enter« the archive, we are in it. In this environment, information is not deposited; it drifts like a cloud. To refer to the archive as a cloud is to suggest that in our globalized world information is a naturally occurring, ubiquitous commodity not tied to any location or a specific cultural technique.[259]

The crucial point here remains that digital archives not only store different things, they also store them differently. As Spieker implies in referring to the operations of cloud computing, this has consequences for storage usage as well. Because digital archives store their goods dynamically, this results in changes to the modes of storage and the means of access alike. When storage spaces are generally becoming transfer storage, the modes of archival opening and closing are also transformed, and the balance between access and preservation has to be readjusted. Following from the work of Wolfgang Ernst, Jussi Parikka summarizes this adjustment as follows: »[...] the archive is becoming less a stable storage place and increasingly a function of ›logistical interlinking‹ [...]. Archives are suddenly not only about storing and preserving but about transmitting [...].«[260]

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257 Lisa Gitelman, *Paper Knowledge: Toward a Media History of Documents*, Durham, NC: Duke University Press, 2014.

258 Cornelia Vismann, *Akten. Medientechnik und Recht*, Frankfurt am Main: S. Fischer, 2011, 305.

259 Sven Spieker, »Manifesto for a Slow Archive,« *ARTMargins Online*, January 31, 2016, https://artmargins.com/manifesto-for-a-slow-archive/.

260 Jussi Parikka, *What is Media Archaeology?*, Cambridge, UK: Polity Press, 2012, 123.

With respect to media logistics, it should be noted at this point that contemporary depots often appear to the casual viewer to be disorganized—especially when they are not run according to hard drive systematics. Logistical theory speaks of chaotic or free storage[261]—but this does not denote a fundamental lack of order in technological storage management; rather, it is an intentionally distributed efficiency model of precise addressability. Goods here are not assigned to any fixed storage spaces predetermined by a classificatory system, but simply to those spaces that happen to be free, available, the right size, and directly accessible at the time of storage. The storage management technology of the depot is put »in motion,« increasing mobility through an orientation toward operations of flexible temporary storage.

The tendency to replace the fixed location system with the random location system[262]—a major trend even before GPS since the implementation of radio-frequency identification (RFID) using microchips,[263] a trend that by now has closely linked the fluid positioning of transport goods and transport work(ers)[264]—is comparatively more similar to the archive than, for instance, the library.[265] Nevertheless, even from archival standpoints the location of storage is not an arbitrary position. In converting to digital processes, which in many respects rely on relational databases, the coordinate system of media

261 Wolfgang Ernst connects this model with a concept of the internet as an »open encyclopedia« (Ernst, »Zwischen(-)Speichern,« 103). David Berry points to the »flatness« produced by the warehousing practices of leading online mail-order companies: »Amazon uses a principle of simplicity and an idea of ›flatness‹ to create a computational archive of physical objects. All objects are treated as records to be entered into a database, and they are processed through a grammatization framework which flattens the object not only into the data store but also within the warehouse space: the singularity of the object is, in other words, abstracted away by the technology. Objects are retrieved using computer-controlled robots from Kiva Systems, which glide swiftly and quietly around the warehouse. To do this, Amazon uses a so-called ›chaotic storage‹ algorithm that optimizes storage through mediating databases. [...] Amazon knows the exact dimensions of every product in its warehouses and the exact dimensions of vacant shelf space. The robots glide the objects to be stored to the most efficient places. [...] From the outside, the Amazon system looks horribly disorganized and illogical. In fact, the warehouse represents the objectification of the chaotic storage algorithm« (Berry, »The Post-Archival Constellation,« 110).

262 Cf. Harald Ehrmann, *Logistik. Kompendium der praktischen Betriebswirtschaft*, Herne: Kiehl-Verlag, 2008, 349f.

263 Cf. the foundational work: Christoph Rosol, *RFID — Vom Ursprung einer (all)gegenwärtigen Kulturtechnologie*, Berlin: Kadmos, 2008.

264 Cf. Rossiter, *Software, Infrastructure, Labor*.

265 Cf. Shannon Mattern, »Middlewhere: Landscapes of Library Logistics,« *Urban Omnibus*, June 24, 2015, https://urbanomnibus.net/2015/06/middlewhere-landscapes-of-library-logistics/.

technology is altered. It is not the position here that is stable, only the address. Even in data depots, archivally received and discharged information is not deposited randomly, but repeatedly »structured«[266]—in relational databases, in the strict sense of the term, it is structured in such a way that end users do not have to be aware of and understand the data space, the inner systematics of storage allocation, in order to be able to carry out meaningful data operations, as David Gugerli has asserted in reference to the pioneering work of Edgar F. Codd: »Codd promised that a relational database structure would serve a substantially larger group of users who might be naive about information technology but who knew how to query.«[267]

II.1.4 Remote Access, Granular Exploration

When database management technologies enter into the archive, modifying their storage operations, but above all establishing novel modes of direct access, this changes how users interact with the collection as a whole as well as the operability of discrete archival objects. On the basis of database management systems, the entire holdings are prima facie less closed off to the archive user, more immediately understandable and searchable. They are articulated instantaneously and algorithmically. Facilitated by queries, a form of pragmatic transparency is produced, which is based, however, on blackbox technologies, which also tend to make the arrangement of the archive—its infrastructures, processes, and the media that support it—invisible.[268] If conventional archive consultation was sometimes a more laborious and costly process, more hierarchically structured, defined by entry barriers, viewing prohibitions, and the communication of institutional authority—Arlette Farge has impressively described the institutional rituals and »entrance permits«[269]—now it is

266 On the significance of data structure for storage media, cf. Manovich, *Software Takes Command*, 201f.

267 Gugerli, *Suchmaschinen*, 71. This principle becomes generalized in web-based database operation, as Martin Warnke writes: »Databases facilitate access by many, they compensate for a disadvantage of the web as it was designed by Sir Tim Berners-Lee. With the appropriate technologies on the part of the large database operators, one can participate without having to know a lot about technology. A content management system ensures that users can make entries by means of web forms, that these find their way into databases and are then displayed on web pages, where they can be seen by others« (Warnke, »Datenbanken als Zitadellen,« 133).

268 In this vein David Berry speaks of a »computational opacity« (Berry, »The Post-Archival Constellation,« 105).

269 Arlette Farge, *Der Geschmack des Archivs*, Göttingen: Wallstein, 2011, 40ff.

governed by low-threshold remote access and navigation tools optimized for operation.

The historian Lara Putnam approaches this conversion from a meta-historiographical perspective: »Web-based full-text search decouples data from place. [...] Digital search offers disintermediated discovery. Algorithms fetch for us, doing away with the need for intermediaries like brick-and-mortar stores [...].«[270] The fact that the encounter with archival objects is always also an encounter with archival policies that one must »obey«[271] nolens volens—even if from the labyrinthine opacity of the archival space there comes the digital promise of an unmediated view (which is de facto algorithmically and microtemporally determined)—remains a relevant point for archival reservations, even under the conditions of »visibility depots«[272] regulated by computer networks. At any rate, the storage objects here do not have to be made accessible linearly or by directly tracing storage practices of hierarchical classification; rather, they are sorted instantaneously on demand, in ›real time‹—whether as inventories that are dynamically constructed and reconstructed, or, in the case of digitized copies stored in the form of databases or digital objects without analog antecedents, in direct connection with playing out and visually (re)generating the requested data sets through software.

This access is no less ›mediatized‹ at any level, only mediated differently. Tendencies toward opening up and democratizing, toward an increasing popularity of the archive,[273] stand in contrast to new kinds of opacities and concentration of power. The fact that the haystacks of the secret service as well as the big data collections of private enterprise comprehensively register digital acts of communication, storing and processing them over long periods of time, has entered into large segments of the public discussion—even if more significant consequences for the politics of information and data protection laws have thus far failed to materialize, even post-Snowden. The once dominant concern

270 Lara Putnam, »The Transnational and Text-Searchable: Digitized Sources and the Shadows They Cast,« *American Historical Review* 121/2 (2016), 377–402, here: 377.

271 Farge, *Der Geschmack des Archivs*, 40.

272 In his history of knowledge of the archive, Markus Friedrich states that his term »visibility depot« should not simply be understood as the passive storage of textual documents, but as the sum of archive-related practices that take place in various social spaces and must be negotiated with the historical tradition of governance and administration of an »administrative organ« (Max Weber) (Friedrich, *Die Geburt des Archivs*, 17ff.).

273 Cf. Urs Stäheli, »Die Wiederholbarkeit des Populären: Archivierung und das Populäre,« in: Hedwig Pompe, Leander Scholz (eds.), *Archivprozesse. Die Kommunikation der Aufbewahrung*, Cologne: Dumont, 2002, 73–82.

about the shelf life of carrier media and data rot seems to have been largely replaced by a skepticism about storage that does not forget anything.[274]

A discursive effect associated with these widespread reservations addresses the dimension of access to digital archives. Access is again being discussed more strongly in relation to the asymmetries of the access to storage. Thus dealings with the newly emerging archival databases can also only be understood against the backdrop of those »digitally fostered values«[275] that are shaped above all by the use of commercial search engines and platforms.[276]

From an archival theory perspective, alongside the general extensions of storage, it is also important that digital collecting technologies have »invasive« tools at their disposal, which not only process the full inventory through information technology, but also facilitate fine-grained explorations of documents: »as access not only *to*, but *into* the documents themselves.«[277] Lisa Gitelman has narrated this evolution as a media history of the document, which arrives in the present day of digital archival practices with the portable document format (PDF):

> Unloved or not, the portable document format has succeeded by dint of the ways in which it imagines and inhabits the genre of the document mobilized within the digital environment. The format prospers both because of its transmissiveness and because of the ways that it supports structured hierarchies of authors and readers (›workflow‹) that depend on documents. […] Using a file manager application to look on your own hard drive for a PDF is something like rooting through a filing cabinet,

274 Cf. Jeffrey Rosen, »The Web Means the End of Forgetting,« *New York Times*, July 21, 2010.

275 Hoskins, »Introduction to Digital Memory and Media,« 3.

276 Debra Ramsay has produced an exemplary study of this connection in a work of media ethnography. Her concrete example is the development of a new interface for the archive website of the British National Archive (TNA). Representatives of the institution had to cooperate with web designers on the conception and implementation of this website. A fundamental area of conflict became apparent in the result: »User expectations generated by familiarity with commercial websites such as Google exert a definite and tangible pressure on the process of interface design in archives, and are increasingly inflecting perceptions of what is accessible from the past and how it can be accessed. But the design process demonstrates that commercial design principles are not simply or blindly implemented within heritage organisations like TNA, because the archive itself pushes back against them by asserting and upholding archival responsibilities and identity through a series of representational strategies« (Debra Ramsay, »Tensions in the Interface. The Archive and the Digital,« in: Andrew Hoskins (ed.), *Digital Memory Studies: Media Past in Transition*, London: Routledge, 2017, 280–302, here: 299).

277 Ernst, »Zwischen(-)Speichern,« 104.

> if you could ever root through files paying attention only to file names and locations, and not to things like thickness or signs of wear. And if you can let go of the idea that the document you call to the screen is actually entirely the same (rather than just looking the same) each time you call it up. Searching computationally for PDFs is different, though, both because searching can rely on data and metadata that go beyond file names and because of the ways that today's searchable databases, at least, render location as relation.[278]

The PDF—the dominant format for digitally distributed written documents—thus reinstalls a hierarchy between readers and authors, readings and revision, while physical-material document information is replaced by the theatricality of software. Software ›performs‹ the supplied files following a »chain of command«[279] originally created according to the specifications of the work flow of private industry »file management« (Vismann), thus ›performing‹ the written information as a new ›piece‹ each time it is opened.

For Gitelman, what is decisive in this context is that originally analog »paper knowledge« becomes digitally accessible in the mode of the self-invoking citation: »Whatever else they are, digital and (even more so) digitized documents appear as pictures of themselves.«[280] Printedness is then expressed without paper, as a compressed image of a page of text, optimized for transmission, which may not be changed without authorization, but can be examined in great detail as a content stream. If such a document is digitized using an optical character recognition program (OCR), the information it contains exists as discrete values, which database management technologies can compute literally down to the last comma. A direct consequence for historians—the »prototypical«[281] archive user group—consists in the possibility of searching entire collections micro-historically according to any random alphanumeric character string, as Putnam notes: »Text-searchable sources make it possible

278 Gitelman, *Paper Knowledge*, 133.

279 Ibid., 127.

280 Ibid., 114.

281 On the ›impregnation‹ of the concept of the archive in historical scholarship, Lorraine Daston has noted: »So complete and exclusive has the identification of archive with the discipline of history become that any other kind of archival research is assumed to be ipso facto historical in nature, and any archive to be of the sort prototypically investigated by historians: a fixed place with a curated, often official collection consisting mostly of old unpublished papers. […] Not only does archival research dominate the imagination of the historians; the historians' archives dominate our collective imagination of all archival research« (Lorraine Daston, »Introduction: Third Nature,« in: Daston (ed.), *Science in the Archive: Pasts, Presents, Futures*, Chicago: University of Chicago Press, 2017, 1–14, here: 2f.).

to trace individual people (or songs, or pamphlets, or phrases), allowing us to observe at the micro level the processes that generate, in the aggregate, macro-level flows and connections.«[282] From this perspective, digital archive documents constitute data pools that can be evaluated in great detail for granular historiography,[283] which can easily be scaled up globally based on networked holdings.

The manifest limits of this form of translocal archival evaluation arise on the one hand from unequally distributed resources for digitization, from the disparity between the Global North and Global South, from the consequences of the digital divide for the accessibility of subaltern archives.[284] Whatever resists in analog form is not distributed; it initially moves into a comparatively peripheral orbit and ultimately loses its connection to the preferentially utilized archival flow of information. The non-digitized accumulates disadvantages in the economy of visibility and ends up on a path of increasing inaccessibility that can only be reversed at certain points: »[…] the Archives are hemorrhaging visitors as people believe they can access everything online. And the reliance in the capacity of digital search can mean paradoxically that less is found, for example, in the loss of the interpretative complexity embedded in the material and in the ›contextual marsh‹ of paper records.«[285]

On the other hand, however, genuinely digital forms of source readings emerge that have reached numerous disciplines under the label of Digital Humanities and shifted their theoretical self-understandings into a new range of questions.[286] Documents are transformed into data sets, which can also be processed in ways that go beyond database queries initiated for general research purposes. There is a trend toward replacing »immersive reading«[287]

282 Putnam, »The Transnational and Text-Searchable,« 386.

283 Gehl summarizes the granular calculation as follows: »The larger the archive, and the more granular the data about the desires, habits, and needs of users, the more valuable the archive. And if the archive is reliably linked to users who can sort data and process digital artifacts, the archive can be grown and made more precise« (Gehl, »The Archive and the Processor,« 1239).

284 Cf. Maja Kominko (ed.), *From Dust to Digital: Ten Years of the Endangered Archives Programme*, Cambridge, UK: Open Book Publishers, 2015.

285 Hoskins, »Introduction to Digital Memory and Media,« 4.

286 Cf. David M. Berry (ed.), *Understanding Digital Humanities*, Basingstoke, UK: Palgrave Macmillan, 2012. For a perspective on the Digital Humanities from the science of history, see: Jörg Wettlaufer, »Neue Erkenntnisse durch digitalisierte Geschichtswissenschaft(en)? Zur hermeneutischen Reichweite aktueller digitaler Methoden in informationszentrierten Fächern,« *Zeitschrift für digitale Geisteswissenschaften* 1 (2016), DOI: 10.17175/2016_011. More on this in chapter II.3 (Computing Video Data).

287 Putnam, »The Transnational and Text-Searchable,« 388.

that is bound to a certain place with an epistemology that, from any given location, subjects large amounts of data to scanning that is tentative, easily variable, and capable of serial comparison. »Applying computer power to historical documents«[288] begins with commonplace database search queries and ends in various models of »non-human readings of storage,«[289] in an adjustable distant reading of digital or digitized documents. The ›readers‹ of streaming archives accordingly also include algorithms that are formatted to be eager to learn (namely, increasingly ›self-learning‹ algorithms[290]).

Michel de Certeau foresaw the impending advent of computer data processing in the historiographic use of archives already in the 1980s and warned of the modes of reading that would prevail there. The fact that archival collecting is not a passive storage process, that ›history‹ is generally not so much read and reconstructed from storage as it is invested in storage and »made« by »redistributing« archival objects—an epistemological process that must necessarily be realized in (ideally reflexive) dialogue with the organization of the archive—is translated with the »technological institution« of the computer into the granular evaluative calculations of computable data pools. On the formalized basis of technological storage, ›history‹ becomes adjustable and programmable from the archival data room, becomes the temporary storage product of »relational models,« which derive historical ›meaning‹ from serial calculating operations, from »model changes,« as Certeau writes:

> [History as it has been practiced in the past] customarily began with limited evidence (manuscripts, rarities, etc.), and it took as its task the sponging of all diversity off of them, unifying everything into coherent comprehension. [...] The often monstrous quantitative development of the search for documents had the result of introducing into the interminable process of research the very law that made it obsolete as soon as it was completed. A threshold has been passed, and beyond it this situation is inverted. [...] With the computer, the quantity of information that can be studied in relation to these norms has become endless. Research has totally changed. Based on formal entities that are deliberately put

288 Ibid., 400.

289 Ernst, »Jenseits der AV-Archive,« 87.

290 »Algorithms are introduced to write new algorithms, or to determine their variables. If in turn this reflexive process is built into an algorithm, it becomes ›self-learning‹« (Stalder, *Kultur der Digitalität*, 178).

> forward, it is drawn toward the deviations that are revealed through logical combinations of series. It plays on the limits of models.[291]

Instead of beginning with vestiges that must be extrapolated into synthesis, the computer represents a historiographical procedure that presupposes »formalizations« that, aside from quantifiable results, only produce surpluses at the margins of the model. What falls by the wayside, according to Certeau, are forms of historical understanding that rely on ›incomputable‹ readings of a heuristically collected, decidedly selective body of sources.

Even a few decades of media history later, however, this could be countered by the fact that the amount of information is still not infinite nor has it plateaued, even if the prophets of big data would like to imagine the timeline both back into the past and forward into the future as navigable at will. The limited machine readability of the historical world, as we will see in chapter II.3, can be demonstrated directly with regard to the particularly resistant digital image repertoire. But even the aforementioned OCR software represents exactly the circumstance that the expanded computability of areas and types of documents that have been datafied to varying degrees is fundamentally carried out step by step.[292] Potentially processable archival data holdings are undoubtedly being expanded, but this dynamic, firstly, encounters resistance and, secondly, has a history of its own that can be told, for instance, as the media history of archival access.

II.1.5 Pastness, Nowness

The idea of an »endless« amount of information in the sense of an automated, complete transcript of the past in data form ultimately belongs to the often dystopian narrative of an assault orchestrated by real-time technologies on ›historicity‹ itself. The supposed permanent ›presentness‹ initially appears

291 Michel de Certeau, *The Writing of History*, New York: Columbia University Press, 1988, 78–79.

292 Lara Putnam has also indirectly pointed to this: »We took the enduring remains of state and church recordkeeping—censuses, parish records, tax rolls—and coded and calculated. What is new now is not computation per se but digitization and OCR, which make *words* above all available, whether for web-based discovery or for automated analysis. This mass data-fication of words is just one subsection of ›the digital‹ impacting academe, but it is a huge one. Not only is it the shift that has remade the information landscape for search, but it is also the driver for those tech-engaged historians experimenting with topic modeling, sentiment analysis, and other text-mining computational approaches« (Putnam, »The Transnational and Text-Searchable,« 400).

here as a discursive figure that emerges, like an inevitable temporal consequence, so to speak, from the general opening dynamics[293] of streaming archives. These dynamics range from intra-archival networks and the standard of remote access to algorithmically opened or ›readable‹ documents, leaving in their wake the question of what to make of an archive that is no longer capable of implementing its normative essence—the distinction between »what is worth preserving and what is not.«[294]

The inclusion of minoritarian, marginalized, »humble« archives ›from below,‹ which could originally be told as a history of progress, thus tilts with the continuously expanded storability of an almost completely datafied reality into a dysfunctional ›total archive‹ that inscribes ever more finely grained presents, but threatens to lose sight of the fact that archives produce historicity by evaluating, selecting, creating temporal distances and distances between archival holdings and non-archival holdings. In the explicit non-preservation of documents that are negatively selected, that is, become objects of cassation, the logic of archival evaluation is expressed as a closing of storage and organized obsolescence, which initially comes into effect on two levels: as a conservational »stored forgetting« (which remains in the »latent memory«) and as a targeted exclusion from storage, which may not lead to »imposed forgetting« (censorship), but does result in a higher probability of forgetting.[295] The cycles of obsolescence that devalue the hardware of storage technologies are another form of forgetting that would need to be taken into account in the overall balance of what should be preserved, as John Durham Peters has noted: »The outmoding of storage media has become a fact of life. Massiveness of documentation, fragility of preservation: this is our condition.«[296]

Where there is no selection, where forgetting and removal from visibility is not possible in any form, the archive ultimately develops »into the double of the general.«[297] The effect of an unlimited expansion of memory is thus paradoxical, as the idea of gapless, non-selective storage would de facto block

293 Ina Blom rightly points to diametrical dynamics that exist due to novel options in digital closure: »Digitization seems, at least in theory, to promote a radical democratization of memory: everything may, potentially, belong to everyone. A proliferation of digital paywalls and passwords is the reality; vestiges of a bounded, territorial concept of space, just like the duplicitous concept of storage« (Blom, »Rethinking Social Memory,« 13).

294 Stäheli, »Die Wiederholbarkeit des Populären,« 74.

295 Cf. Assmann, »Archive im Wandel der Mediengeschichte,« 168.

296 John Durham Peters, »Proliferation and Obsolescence of the Historical Record in the Digital Era,« in: Babette B. Tischleder, Sarah Wasserman (eds.), *Cultures of Obsolescence: History, Materiality, and the Digital Age*, Basingstoke, UK: Palgrave Macmillan, 2015, 79–97, here: 80.

297 Stäheli, »Die Wiederholbarkeit des Populären,« 75.

access to older layers of storage. The »archive of the present« understood in this way would not actually be an archive at all, since the »media space in which we reproduce the present«[298] does not subside, does not become a past present and thus does not become historical, but is constantly regenerated. The presentness-effects of real-time technologies subvert processes of historicization, delay or prohibit the formation of »historical records« (Peters). In the mode of temporary storage, past presents are constantly overwritten with new presents, that is, tendentially erased.

Assmann describes this form of synchronous co-presence, following Levi-Strauss, against the background of a rising erosion of the »consciousness of the past being past,« for which the institution of the archive can offer only dwindling support in resistance to the real-time transfer of digital communication: »Diachrony is tending toward [...] dissolution in synchrony.«[299] It is the ubiquitous accessibility of networked forms of storage that are able to communicate among themselves and the forms of instantaneous transfer associated with them that thus disturb the formation of historicity. The media-technological ›real-time‹ of streaming archives intensifies distribution, but in doing so it hampers processes that deliberately suspend circulation and connectivity in order to modulate deceleration, distance, forgetting. A prerequisite for the reformatting procedures used to inscribe storage objects into the archive, to referentialize and classify them for the purpose of documenting their provenance, is a temporal stoppage through which selected objects can be infused with the endurance of archival »time reservoirs.«[300]

In the sometimes one-sided, exaggerated emphasis on the lack of historicity determined by media technology, one need not agree with the above diagnosis, which has been proposed in various forms, in order to understand that under the process-temporal conditions of computer networks and streaming data we can in fact assert a different media productivity of ›nowness,‹ which also rebalances the formation of ›pastness‹ in certain respects. The question of the archive offers a heuristically suitable perspective here insofar as the practices connected with it resonate institutionally; that is, in contrast to the rhetoric of unbounded archival semantics, they are associated precisely not with

298 Mercedes Bunz, *Die stille Revolution. Wie Algorithmen Wissen, Arbeit, Öffentlichkeit und Politik verändern, ohne dabei viel Lärm zu machen*, Frankfurt am Main: Suhrkamp, 2012, 119.

299 Assmann, »Archive im Wandel der Mediengeschichte,« 175. Cf. also: Ernst, »Zwischen(-)Speichern,« 94.

300 »The archive provides the time to see and recognize. It resists the tempo of history with its decelerated temporality, and in doing so it makes history perceivable« (Stäheli, »Die Wiederholbarkeit des Populären,« 75).

hypertrophic, undifferentiated forms of storage, but rather with a selective perspective on what parts of the present might be relevant to the future and thus are not collected arbitrarily, but specifically stored, registered, kept available at a »new time point« (Winkler). With regard to the frequently assumed omnipresence, or permanent nowness, of digital data storage, it can be argued at this point with Sven Spieker that institutional archival practices do become capable of producing distinctions once again:

> According to traditional archival doctrine, archives certainly store a great deal, but not necessarily everything. Today, however, the circulation of data and information is increasingly taking place in a global archival space that has lost its outside. In this sense, discussion of the archive is misleading when it refers to the global data memory banks of our day. The problem for us in the present consists less in deciding what an archive is, than in understanding what an archive-free space would have to look like, if it could in fact still exist. And here a paradox arises [...]: the outside of the archive today are those traditional archives that are still concerned with separating what is worth preserving and what is not, with deciding what is of archival value under the given circumstances.[301]

In this model, institutional archives form an exterior of the ›global archive‹ that is turned inward insofar as they are special places of knowledge from which can be observed those excesses of storage that the traditional archive initially attempts to protect itself against—by means of its associated norms, methods, and epistemologies.[302]

But because this interior, which generates storage on its own expense, continuously comes into contact at least at its edges with an environment that has fallen prey to entropy, there arises an obviously permeable contact zone. Against the backdrop of a culture that takes ever more data ever more instantaneously into its stored memory, the institutional archive seems to have shifted in the direction of functional memory, so to speak. It sorts through information and tends to erase what it excludes from the surrounding data storage.

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301 Spieker, »Die Ver-Ortung des Archivs,« 8.

302 David Berry also does not assume that archival cultural techniques are per se infeasible in the media space of the internet: »[...] the Internet is an archive that represents an open-ended ›aggregate of unpredictable texts, sounds, images, data, and programs‹ but that is nonetheless navigable and open to traditional archival practices« (Berry, »The Post-Archival Constellation,« 108).

Under digital conditions, materials that are accepted into an archive, found to be of value and reformatted are generally not so much passively stored as they are kept for reproduction by media technology and pre-activated for transmission processes. This shift, which has already penetrated far into the traditional interior of archives, can be seen in the widespread desire of institutional facilities to lower access thresholds, to communicate access, and often even to produce digital copies and provide them through a variety of channels. The archives also ›stream‹ because a new assessment of distribution is gaining ground. In the model of the transmitting archive, accessibility wins out over the standards of persistence in the competition for institutional relevance: »Archives [want] to become brokers of information at the same level as libraries and similar institutions.«[303] Mere preservation comes under suspicion of producing archive-corroding invisibilities. Many traditional archives are dedicating significant resources to switching their holdings, once protected from use and access, to open distribution. Archival objects and archival arrangements are digitally compiled and copied above all in order to remain connected with the dominant flows of information and therefore to remain accessible. What has been stored is meant to be neither completely nor permanently forgotten. Institutional archives therefore pursue their own specifically calculated storage agendas, while at the same time—with their networked databases organized for streaming—contributing to the ›globalization‹ of data storage, rather than being its antipodal Other in every respect.

It remains relevant, however, to identify the differences between the various modes of storing and distributing. Spieker's model of externalization can be understood as a call for a potentially helpful shift in perspective. Precisely because digital storage calculations have long since come into contact with conventional archival agendas, intentions of handing down content for posterity, resilient referentialization, and the most long-lasting storage possible, the amalgamations that have emerged from this contact open up a very promising field of analysis.

Against this background, a paradigmatic product of this connection in the sense outlined here seems to be the material that the following case studies will examine: archival images that are retro-digitized by institutional agents and distributable as streaming data. An explicit dimension of historicity thus comes into play here, if only because these archival holdings have analog prehistories, which transcoding in some sense splits in two. The images in question

303 Anna Sobczak, *Traditional vs. Virtual Archives—The Evolving Digital Identity of Archives in Germany* [Online Publication: academia.edu], Hamburg, 2016, 6.

exist from the moment of their logistical bifurcation in two states of media-technological storage: as physically tangible objects in concretely localizable archival spaces and as data objects in digital databases that are ready for transmission. A shared archival authority watches over both, guarantees the connection through »chains of transmission,«[304] but equips these related objects with different distributional resources, ranges, practices. They will be examined as examples of distributed historical images—as visual documents of a public authority (the police) and of a historical context of events (the Shoah)—and in this will be approached from a fundamentally media-historiographical perspective. The »medial a priori«[305] here is aimed on the one hand at the entry of digital calculations into archival systems, at the concomitant logistical restructurings. Alongside the historiographically preparable contents of such a (re)distributed history, what is of interest on the other hand is the history of distribution. For digitized objects maintain genealogical connections with early forms of technological image distribution. Their history is likewise stored in the data depots. In addition to storage processes,[306] the archives in question here also preserve documents of distribution history that can be processed in terms of media archaeology.

304 Daston, »Introduction. Third Nature,« 6. According to Daston, these chains of transmission ultimately also guarantee the sustainability of the archive: »Longevity is no accident: a chain of individuals and institutions links Babylonian cuneiform tablets withs NASA's *Five Millennium* canons and the fossils piled up in a seventeenth century cabinet of curiosities with a twentieth-century digital database. At each stage of transmission, key information about the original context in which the archive was compiled might be lost; standards for precision, reliability, and relevance also have their history. Without scholars and scientists, copyists, printers, proofreaders, curators, librarians, archivists, programmers, and the institutions that at every step support them, from monastic scriptoria to the modern university library, the chain would break« (Daston, »Epilogue: The Time of the Archive,« 330).

305 Cf. Lorenz Engell, Joseph Vogl, »Editorial,« in: Engell, Vogl (eds.), *Mediale Historiographien*. Archiv für Mediengeschichte 1, Weimar: Universitätsverlag, 2001, 1–5.

306 Spieker, »Die Ver-Ortung des Archivs,« 19.

II.2 Long-Distance Photographs

Entry into the archive, encounter with a digitized photograph [fig. 1]. The interior view of a shabby, untidy, messy shack. In the middle of the picture a cast iron stove stands askew atop stacks of bricks, serving as a resting place for a pan, a pot, a bowl. On the lower left, carelessly propped against the wall of the wooden shack, is a folded-up newspaper, apparently more kindling than reading material. In the foreground is a metal bucket, in the background, largely obscured by the stove, a wooden cot, a dog curled up beneath it, looking toward the camera. Further sight lines emerging from the space of the past to cross paths with the perspective of present-day viewers assume subject positions that were located outside of the humble abode in the historical moment in which the image was captured. Two men—one in a police uniform, the other in a suit, tie, rimless glasses—focus on the camera, which stands inside the hut in order, as will become clear after further stages of reading, to secure evidence left at a crime scene by means of image technology [fig. 2].

The archive, originally charged with storing such visual evidence, functions as a logistical hinge in a photographic-forensic investigative routine that is meant to produce evidence and make it transportable. The forms of transport and distances associated with this are mapped out as a course for files to follow: from the scene of the crime to the working storage of the investigation and on into the courtroom. The prerequisite for circulation of the material today is its debureaucratization—and an archival shift that allows documents once claimed as investigative tools to become ›historical‹ documents.

What is passed on in this translation process—alongside evidence that can be read for purposes of both police history and local history—are media-logistical traces of how this evidence was officially formatted. Anyone who consults archival materials inevitably—as mentioned in the last chapter—comes into contact with archival systems that are constantly inscribed in the document, but are articulated as such in unequally explicit and transparent ways. In the case at hand, the current contact occurs as mediated by the screen, as an »interface effect«[307] of a data transfer. From the perspective of media

307 Cf. Alexander R. Galloway, *The Interface Effect*, Cambridge, UK: Polity Press, 2012. For Galloway, interfaces are initially not individual objects (screens, displays, keyboards, etc.), but general processes of layer formation, which are thus to be questioned primarily in terms of their ideological productivity (ibid., 54ff.). At least, the initial observation that the mutually interpenetrating »layers« that are repeatedly reshaped in this process generate transparency effects (interface as »window«) and those in which tools and

theory, the immediately perceptible media product of this transmission is a pre-programmed, dynamic exchange process: an interface that both shields the user from the unsightly computer-technical reality of data objects and creates a pragmatic connection with them.

The connective effectivity that this calls up is usually tied to displays and standards of graphic processing (graphical user interface). At the point of contact with the photograph described at the beginning of this chapter, the logic of this interface becomes concrete in the form of an operative user interface, which communicates both the iconically implemented data configuration ›archival image‹ and the archive-related metadata [fig. 3]. However, the data window does not reflect the digital transfer process as such. The user is also effectively shielded from the other prerequisites of information technology necessary for the photograph to become perceivable and operable. Instead, finding aid notations are gathered on the interface. They allow us to read what was and is to be registered from the perspective of the archive. Categorized as »media information,« there is an initial external title that does not simply contextualize the photograph but practically narrativizes it: »Photo of dead body of Marion who was murdered in Shanty at Old Stone Road and Bullshead Golden, 1915, 4 plates.«[308] Furthermore, the finding aid conveys the name of the overarching collection (NYPD & Criminal Prosecution), the archival identifier (de_0238), a »creator« (John Golden), three subjects (Murder, Crime and criminals, Police Department), a date (1915), format specifications (6.25 × 8.25 inches, glass-plate negative), and a relation that points to related materials, to a four-part series of pictures (pde_238, pde_239, pde_240, pde_241).

The selected example of the New York crime scene photograph from 1915, the oldest of the collection published thus far, is therefore embedded in a digitally accessible indexing system that is institutionally coded on the surface—the ›exterior‹ of the interface. Inventory information is stored here that is structured according to an archival model of classification. The finding aid contains indices of facts, locations, and persons, and points to related archival materials belonging to the same file, to the same historical investigative process. The fact that this is a digital archive, accessed by way of a computer network connection, is not conveyed through a rejection of traditional archival standards of communication, but primarily as a matter of operations. To access this archive,

information values are set off against calculated interaction offers on user interfaces (»reflective surfaces«) seems to be compatible here.

308 John Golden, »Photo of dead body of Marion who was murdered in Shanty at Old Stone Road and Bullshead Golden, 1915,« NYPD & Criminal Prosecution Collection, NYC Municipal Archives Digital Collections, https://nycma.lunaimaging.com.

to become part of the chain of operations that can be implemented within it, certain connectivity parameters, certain software and hardware requirements must be fulfilled. The media-technological protocols for transmission and data mobilization regulate access and visibility in combination with interface conventions of graphic mobilization that are performatively played out at the front end: granting entry, formatting access, facilitating operability.

Following Debra Ramsay, it can be noted at this point that even before the implementation of digital information management systems, archives operated through—human or non-human—agents such as archivists or finding aids, which can fundamentally be described as interfaces: »[…] not all the interfaces in operation in archives are digital. At one level, the archival institution is itself an interface because it provides the means for individuals to interact with material traces of the past.«[309] Ramsay nonetheless also recognizes a significant recalibration »through the affordances and limitations of the digital sphere.«[310] Concretely, what changes under network conditions, as outlined in the previous chapter, are the modes of access to digitally mobilized products.

In the case of the web archives run by the NYC Department of Records, the pertinent adjustment can be seen, for instance, in the fact that the photographic digital reproductions are surrounded and infiltrated by various archival tools of digital visualization. On this level, a preliminary phenomenological forensic investigation of the interface registers the following details for consultation: An invasive scaling tool has been placed below the middle of the image in the form of a minus-plus control, which allows for continuous zooming to view enlarged details. When this is activated, an image detail window opens in the lower right that shows which segment of the total photographic surface is currently being examined. Detail view and overview are synchronized. Image software translates the alteration formalized by a raster graphic as a flowing modulation of transmitted pixel values, temporarily stored in the browser's cache. With regard to the seamlessness of the transition, the archival image is to a certain degree ›geomedially‹ processed: »With the boundaries of what is depicted made fluid, an observer can freely select the distance and thus the visible richness of detail […]. This simulated shift in scale can only be meaningfully implemented by zooming, with which the shift from microperspective to macro-perspective can be accomplished […].«[311] As with the interfaces on popular geobrowsing applications, the concern here is much less

309 Ramsay, »Tensions in the Interface,« 286.

310 Ibid., 287.

311 Pablo Abend, *Geobrowsing. Google Earth & Co. — Nutzungspraktiken einer digitalen Erde*, Bielefeld: Transcript, 2013, 188.

with statically representing excerpts of the world than it is about exploring them.[312] Not the whole Earth, but the entire archival image space becomes navigable by algorithms.

The photographic surface that is in this sense operationally opened up, and can therefore be searched for historically significant details on a micro-historical level, contains an additional element that blocks movement, that imposes a kind of visual barrier. A digital watermark crosses the image horizontally, in the written form of a URL. The archive address not only functions as a mark of origin, but above all as an obstruction to usage, thus communicating a copyright claim that is also unmistakably indicated by a button with a shopping cart pictogram situated above the image (»Buy Print«). An unhindered view is meant to be linked to a license or commodified media exchange, whose printedness retro-converts the retro-digitization in the form of producing a (quasi) analog photographic object. A picture requested in this way is then distributed by post [fig. 4].

Further interface functions are aimed at feeding social media and moving beyond the archive or institution (»Embed This,« »Share This«). Others in turn allow for switching between various viewing modes (»Open Media in Full View« vs. »Back to Thumbnails«) and for »culling« (Farge) documents and series of documents that can be copied with a click (»Add to Workspace«).[313] The primary formation of a series that the archive prescribes refers to the historical case: the murder of a woman named Marion that becomes dramatically visible especially in the following three entries in the series. In a preview window on the upper right, there are three comparatively inactive images of the forensic series in miniature view. By double clicking on them, the documents can be »called up« (Gitelman) on the screen, revealing the historical space in further photographic perspectives of the police crime scene forensics. The murder victim lies behind the cast iron stove: »with her throat cut from ear to ear, and a carving knife by her side,« as stated in the October 14, 1915, issue of the *New York American*[314] [figs. 5/6].

The fact that the datafication of the historical photographs is not limited to retro-digitization and the transmission process, but also entails integration into a database management system, can be seen most obviously in the search

312 Ibid., 152.

313 »After you have read the documents, you begin culling out some among them, and by the simple acts of copying or photocopying you isolate pieces of the archive. You might make your selection by collecting and assembling things that are similar, or by picking out specific items; it all depends on the subject being studied« (Farge, *The Allure of the Archives*, 63).

314 Quoted in: Luc Sante, *Evidence*, New York: Farrar, Straus and Giroux, 1992, 73.

windows that open whenever the cursor navigates along the finding aid classifications mentioned above: an index that opens itself up in the digital search masks in order to bring its collection into the network, to switch the archive into a stream [fig. 3].

The current archival interface not only has a reality »below the screen«[315] that can be addressed on a number of analytical levels, but also transports evidence that can be interpreted in terms of media historiography. The logistical traces lead in part—as will be addressed more thoroughly later in this chapter—to media and forensic genealogies of shared image storage, a trail that, in terms of institutional history as well, connects today's streaming forms with phototelegraphic operations. But before we come to this point, it is first necessary to relate the contemporary distribution of material—as networked documents of a digital city archive—to previous phases in the history of the publication and circulation of the NYPD Photo Unit's collection, which has been successively retro-converted since 2015. The context of discovery and transmission here leads directly to questions of transformation through media—with regard to the institutional framework, redistribution, de-datafying and re-datafying, and finally also the »chains of transmission« (Daston) involved in the media-technological transcoding processes.

II.2.1 Computing the History of Crime Scene Pictures

The publication history that is directly relevant to the current visibility of the materials from the NYPD Photo Unit begins in a certain sense with a discovery by the Belgian-American writer, artist, and urban historian Luc Sante. At the beginning of the 1990s, while researching a book project—which ultimately appeared under the title *Low Life: Lures and Snares of Old New York* and recounts with rich detail the history of the Lower East Side Tenements starting in 1850[316]—he came across a box of glass plate negatives, stacked together in no particular order, which had only recently been discovered under some basement stairs at the Police Headquarters on Mulberry Street when it had to be cleaned out: »I stumbled on the collection of some 1400 photos from the New York Police Department, dating from 1914 to 1918, that were held in the city's Municipal Archives: images mostly of crime scenes, of murder victims

315 Galloway, *The Interface Effect*, 54.

316 Luc Sante, *Low Life: Lures and Snares of Old New York*, New York: Farrar, Straus and Giroux, 1991.

pictured on the sidewalk or in their narrow bedrooms, often from overhead, with angles so wide the tripod legs appeared to encase the dead.«[317]

The glass plate negatives—before the influential discovery of a plastic compound produced by mixing cellulose nitrate and camphor, photochemical emulsions could only be applied to coated metal or glass surfaces, or starting around 1870 also to dry panes of gelatin—had survived a decluttering campaign carried out in the 1950s, during which, according to John R. Podracky, a staff member of the City Archive, thousands of glass plate negatives that had become a useless burden to the police discretely disappeared into the East River.[318] This chance discovery was also made possible by the materiality of the substrate: glass plate negatives seem fragile, but they are comparatively robust and impervious to archival neglect through environmental influences like heat and humidity. If they do not end up in pieces at the bottom of the East River, they survive for quite some time even without any conservational care.

Evidence is the laconic title of the book that Sante eventually published as a kind of material compendium to the city's history told ›from below‹ in *Low Life*.[319] It includes (peppered here and there with indulgent Barthesian commentary) 55 forensic photographs, many of which were taken with wide-angle lenses and using magnesium flash, often also with vertical views that initially seem peculiar, sometimes capturing the base of ladder stands and the tips of the police officers' shoes. Puzzling images that can only be referentialized with the historical circumstances of their creation selectively by means of individual file notes, images that serialize New York in the medium of crime scene photographs. Archived traces of violence that produce documents of their own kind, above all due to the specificity of the bureaucratic perspective directed at these traces.

The history of this perspective is tied in many respects to the administrative modernization of law enforcement agencies. Criminalists like the French inventor of anthropometric identification, Alphonse Bertillon, and his American colleague Thomas F. Byrnes, who presided over the New York City Police Department in the 1880s and produced the illustrated book *Professional Criminals of America* (1886), one of the most extensive ›rogues galleries,‹

317 Luc Sante, »A Roomful of Death and Destruction,« *The New York Review of Books*, June 22, 2015, https://www.nybooks.com/daily/2015/06/22/nypd-photo-archive-death-destruction/. Cf. also: Michael Wilson, »Dusting Off a Police Trove of Photographs to Rival Weegee's,« *The New York Times*, March 20, 2015.

318 Sante, »A Roomful of Death and Destruction.«

319 Sante, *Evidence*. Cf. also: Gary Weissman, »Evidence: Luc Sante,« *Discourse* 16/2 (1993), 180–183.

ascribed a central function to the photographic medium within an increasingly sophisticated police identification system.[320] The forms of knowledge that emerged from this, as Allan Sekula has clearly shown, »mapped out general parameters for the bureaucratic handling of visual documents.«[321]

Already in the 1980s, research on photography in media studies had begun to address this early incorporation in more detail. A significant aspect of the historical background to how police used photography was identified as the pseudo-scientific phrenological and physiognomic discourses of the nineteenth century, which marked the institutionalization of a criminology geared toward the social sciences and above all were incorporated in the bureaucratic practices of identifying and classifying allegedly ›criminal types.‹

While the image-based media technologies of police identification can now be regarded as well researched—from the central integration of photographic recordings in the anthropometric approach of Bertillon's *portrait parlé*, analog efforts with x-ray photography of skeletons[322] and dactyloscopy, which came into prominence in the 1910s,[323] to recent methods of algorithmic facial recognition[324]— comparatively little attention has been given in media studies to the complimentary modus operandi of photographic forensics as it was established during the second half of the nineteenth century in the investigative and administration activities of government agencies.[325] This refers to crime

320 Alphonse Bertillon, *Die gerichtliche Photographie: mit einem Anhange über die anthropometrische Classification und Identificirung*, Halle: Knapp, 1895; Thomas F. Byrnes, *Professional Criminals of America* [1886], New York: BiblioLife, 2016. On Alphonse Bertillon, cf. Susanne Regener, *Fotografische Erfassung. Zur Geschichte medialer Konstruktionen des Kriminellen*, Paderborn: Fink, 1999, 131–168; on Thomas Byrne: Jonathan Finn, *Capturing the Criminal Image: From Mug Shot to Surveillance Society*, Minneapolis: University of Minnesota Press, 2009, 1–31. On the role of portrait photography for identification in colonial record-keeping practices, cf. Elizabeth Edwards, *Raw Histories: Photographs, Anthropology and Museums*, London: Bloomsbury, 2001.

321 Allan Sekula, »The Body and the Archive,« 56.

322 Cf. Regener, *Fotografische Erfassung*, 145ff.

323 Cf. Francis Galton, *Finger Prints* [1892], Amherst, NY: Prometheus Books, 2006; Simon A. Cole, *Suspect Identities: A History of Fingerprinting and Criminal Identification*, Cambridge, MA: Harvard University Press, 2001.

324 Cf. Roland Meyer, »Augmented Crowds: Identitätsmanagement, Gesichtserkennung und Crowd Monitoring,« in: Inge Baxmann, Timon Beyes, Claus Pias (eds.), *Soziale Medien — Neue Massen*, Berlin: Diaphanes, 2014, 103–118, and Sarah Kember, »Face Recognition and the Emergence of Smart Photography,« *Journal of Visual Culture* 13/2 (2015), 182–199.

325 A recent overview of the current state of research, which still has many gaps to fill, can be found in Christine Karallus's study *Die Sichtbarkeit des Verbrechens*, which considers (unpublished) crime scene photographs from the years 1896–1917 from the historical collection at the Berlin Police Headquarters and the Berlin Municipal Archive. A central topic of the work is the »practices of knowledge and truth in law and criminalistics,«

scene photography, whose results—indexed as ›objective findings‹ in situ, as an on-site inspection that is secured through media technology and able to be mobilized in new ways[326]—are in some cases, such as the Vienna Police Headquarters, among the institution's oldest surviving photographs.[327]

Bertillon had already attempted to systematize photography not only as a tool of police identification and record keeping, but also as a privileged medium for preserving evidence.[328] Photogrammetric procedures were supposed to make it possible to extract the exact values of topographical relations and object distances from crime scene photographs. In this context, the photograph is not understood merely as an image of a crime scene, but as a photogram—as a data set with which calculations can be made, as Stephen Monteiro writes:

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which, starting in 1903, allowed crime scene photographs to become pieces of evidence in criminal proceedings and thus can be regarded in terms of an »iconic turn« in legal history (Christine Karallus, *Die Sichtbarkeit des Verbrechens. Die Tatortfotografie als Beweismittel*, Berlin: Logos Verlag, 2017; on the state of research, see esp. 24ff).

326 Cf. ibid., 153ff.

327 In this context, Walter Menzel has noted that crime scene photography raised archival questions from the very beginning: »Between 1870 and 1880 crime victims and crime scenes were photographed by officers from individual police departments—at first without the knowledge of the Vienna Police Headquarters. When these photographs attracted attention during an internal inspection in 1880, this led to the first reflections on systematic archiving and centralized collection. This is noteworthy because it resulted in the development of a tradition that became a specialty of Viennese police photography beginning in the 1890s under the influence of anthropometry. It has thus been a standard practice of the Vienna Police since the late 1890s to use special photographic equipment with a high level of technical precision to take photographs of crime scenes and corpses in order to obtain an exact and undistorted image of the scene. These photographs became increasingly valuable for forensic medicine and within criminalistics« (Walter Menzel, *Tatorte und Täter. Polizeiphotographie in Wien, 1890–1938*, Wien: Album Verlag, 2007, 21f.). Cf. also Christine Karallus, »Spuren, Täter und Orte: Das Berliner Verbrecheralbum von 1886 bis 1908,« *Fotogeschichte. Beiträge zur Geschichte und Ästhetik der Fotografie* 70 (1998), 45–54.

328 Most histories of crime scene forensic photography begin with the assassination of Abraham Lincoln: »Photography's role in two high-profile investigations of the 1860s and 1870s helped establish its place as a practical tool in police work. The first was the hunt for suspects in the aftermath of U.S. president Abraham Lincoln's assassination in 1865. Government-issued wanted posters included albumen carte-de-visite format photographs of the principal suspects, while the Secret Service called upon Alexander Gardner to photograph the crime scene, the convicted conspirators and their subsequent execution« (Stephen Monteiro, »Crime, Forensic, and Police Photography,« in: John Hannavy (ed.), *Encyclopedia of Nineteenth-Century Photography* Vol. 1, London: Routledge, 2009, 344–345, here: 345).

> Bertillon contributed greatly to this field [of forensic photography] by devising metric photography—the inclusion of a measuring scale in photographs to provide a permanent record of the scale and relationship between objects at a crime scene. […] Despite occasional examples reaching as far back as the 1860s, crime scene photography only became standard practice in the closing years of the 19th century, as police departments hired staff photographers and the invention of flash photography made on-the-spot field work practical. Metric photography became fundamental to such activities, employing wide-angle lenses and large plates to capture fine details while photographing at precise angles (often directly overhead) with measuring scales that permitted accurate computation of distances.[329]

From a forensic perspective, the photographic »computability« of a crime scene is meant to archive the scene for processing the conditions found there at a later point in time and in a different location. To this end, in order to adjust the mode of crime scene photographs—which are embedded in files as epistemically addressable storage of images of local circumstances and which ultimately end up in the archival holdings of an agency—from »descriptive« to »exploratory,« a specific bureaucratic datafication of the image is required, in which the visually stored information is surrounded with metadata and only then rendered legible as a value, as Katharina Sykora has shown with regard to Bertillon's *service de l'identité judiciaire*.[330] In this sense, the two-fold trace logic of photographic recordings—the traces left at a crime scene, which can be evaluated as evidence using rule-governed forensic coding, are stored by a visual technology that for its part is ascribed an indexical, mechanical-objective

329 Ibid.

330 »Technical data about the photographs such as the direction of the optical axes and the distance of the lens from the ground […] were added. On the side [of the cardstock] were noted the coefficients of the reductions and of the distances of objects in relation to the lens. […] Descriptive crime scene photography […] is primarily concerned with optically establishing and storing facts, which then make their way into police and court files as information, while exploratory crime scene photography seeks to provide evidence […]. In order to do this, however, they have to produce an overabundance of visual information about the spatial conditions of the event, from which evidence can be drawn after the fact. These abundant visual data have to be arranged systematically in order to be decipherable« (Katharina Sykora, *Die Tode der Fotografie I. Totenfotografien und ihr sozialer Gebrauch*, Paderborn: Fink, 2009, 502f.; on post-mortem photographs prepared as part of forensic autopsy, cf. ibid., 498ff.).

relationship to the historical world[331]—fulfills only the first part of the forensic promise. The »traces preserved in the abundance of photographic data«[332] are intended to become objective through systematically gathered and recorded metadata, through details about image acquisition implemented according to standardized protocols, and through the use of metric tools, in order to be preserved in a forensically computable form rather than merely documentary. Bertillon's department not only dreamed of securing direct evidence (ultimately for use in court), but of a datafied photogram, which could be expressed numerically and calculated according to certain rules. The preservation of evidence was intended to become an investigation, the cross section of space and time captured photographically was meant to be connected to the processual temporality of bureaucratic data processing.

This thread in the history of the forensic datafication of photographic practices can be traced into the present day of image-based forms of biometric registration, in which the continuous monitoring of spaces (as potential crime scenes)—using video streams that are automatically compared with databases—practically coincides with the algorithmic identification, independent of any actual suspicion, of the persons acting within those spaces (as possible perpetrators).[333] As David Gugerli has shown, the actions of the *Bundeskriminalamt* (BKA, the Federal Criminal Police Office of Germany) under the direction of Horst Herold—whom the news magazine *Der Spiegel* once dubbed »Commissioner Computer« in view of his »negative dragnet investigation« during the events of the German Autumn 1977—can be understood here as an intermediate stage on the path to more recent procedures of digital dataveillance.[334] Central to Herold's agency's operational understanding of the image was an electronically administered database system for »persons, institutions, objects, and things« (known in German as »PIOS«), which was fed with photographs of persons, forensic crime scene photos, photographic recordings of fingerprints and handwriting samples. The newly hired visual database programmer sought out technological solutions for how photographic grayscale images could be compared with existing facial composite sketches in the form of graphics,[335] how pattern recognition—instrumentalized as pattern

331 Cf. Lorraine Daston, Peter Galiston, »Das Bild der Objektivität,« in: Peter Geimer (ed.), *Ordnungen der Sichtbarkeit. Fotografie in Wissenschaft, Kunst und Technologie*, Frankfurt am Main: Suhrkamp, 2002, 29–99.

332 Sykora, *Die Tode der Fotografie I*, 508.

333 More on this below in Part III.

334 Cf. Gugerli, *Suchmaschinen*, 52–69.

335 Ibid., 62.

recognition of social deviance through a mainframe—would be implemented on the basis of photographically stored visuality. Herold was also already interested in modes of image distribution accelerated by computers—Gugerli mentions here the phototelegraphic transmission of crime scene fingerprints and the INPOL (Joint Electronic Information System) network that operated via the Telex teleprinter[336]—with a larger focus on logistical infrastructures, which were meant to make it possible to transport and address criminological data instantaneously:

> A search engine of unprecedented magnitude was created in Wiesbaden, operating with files that could be indexed, compared against one another. In order to ensure their functionality, every description of perpetrators and crimes held in crammed filing cabinets had to be brought into shape, and this meant translating them into mobile data. […] Herold dealt with the agency's flood of paper information by transforming how it was recorded, stored, and called up, or to put it another way: facts were systematically assigned addresses, and were thereafter available as database entries that could be called up at all times and combined at will—that is, in the form of data.[337]

II.2.2 Aestheticization as De-Datafication

The logistical mobilization of forensic photographs as data images outlined above leads, in a certain sense, to that media form that was analyzed at the beginning of this chapter with the example of a crime scene photograph from 1915: the networked document of a digital archive. The prerequisite for the concomitant media-technological and archival datafication, however, is a bureaucratic declassification. In the academic literature, this provisional de-datafication of crime scene photography has been treated first and foremost under the catchword of aestheticization and traced back to the effects of institutional redistribution in the direction of the art world. Even before their entry into publicly accessible digital archives like those of the NYC Department of

336 The vision of machine-readable transportable images was also already present here: »A fingerprint, for instance, had to be established as a trace and fixed as an image before it could be projected onto a screen ›magnified a thousandfold.‹ The anatomical peculiarities of the papillary lines could then be translated into mathematical formulas and their variables entered into a data file. This allowed for a machine-searchable expression for individual clues from a crime scene« (ibid., 60).

337 Ibid., 55–56.

Records, crime scene photographs began circulating outside of official channels for files, turning up in a curated form in coffee-table books and gallery spaces, becoming objects of pop cultural and artistic appropriation.[338]

A decisive driving force behind this diffusion may have something to do with an aesthetic excess. The everyday heterogeneity of the crime scenes, the contingency and abruptness of the crime, generates—precisely in comparison to the visually standardized police identification of the Bertillon system—a surplus of extra details that are also stored, provoking non-bureaucratic or extra-bureaucratic readings.[339] Susanne Regener sees this as the general cultural tendency toward a »mystification of the portrait of the corpse,« which is detached from the production of criminological knowledge and converted, precisely through the altered modes of circulation, into an »utterly aesthetic state«: »The crime scene photo has long since broken away from its original function and has entered into the area of conservation in museums, everyday popular culture, or aesthetics and art.«[340]

338 This phenomenon begins in the 1990s but can still be observed to this day. Along with Luc Sante's *Evidence*, we could mention the most recent example of such an illustrated book, published by James Ellroy in cooperation with the ambitious museum of the Los Angeles Police Department (James Ellroy, Glynn Martin (eds.), *LAPD '53*, New York: Abrams Image, 2015). When crime scene photographs migrated into the museum space, this initially also happened by way of press photographs of crime scenes. The most familiar example here would be the photojournalism of Arthur Fellig, which was exhibited at the New York International Center of Photography (ICP) in 1997 under the title »Weegee's World: Life, Death and the Human Drama.« In 2002, Robin Blackman, Rick Morton, and Tim B. Wride curated an exhibition with the title »To Protect and Serve: The LAPD Archives,« which was later also exhibited in Zurich (2005) and Düsseldorf (2006) (for connections to works by Eugène Atget, Man Ray, Andy Warhol, cf. Erik Morse, »Scene of the Crime,« *frieze* 164, May 29, 2014, https://www.frieze.com/article/scene-crime). While Weegee represents a historical tabloid culture and Ellroy's noir poetics is interested in pop-cultural paraphrasing, artists such as Melanie Pullen (*High Fashion Crime Scene* 1995–2005) or Izima Karou (*Landscapes with a Corpse*, 1995–2008) focus on stylized photographic re-enactments of forensic archival material (cf. Katharina Sykora, *Die Tode der Fotografie II. Tod, Theorie und Fotokunst*, Paderborn: Fink, 2015).

339 Katharina Sykora interprets the quasi-historiographic mode of reading traces that is inevitably triggered by reception aesthetics: »The tangible trace at the scene of the crime and the visual trace in crime scene photography not only have [...] the potential to lead us back to the crime [...]; they charge both the crime scene and photographs of it with the aura of the crime, which ›overpowers‹ us. [...] By reading these traces, exegetes have attempted to work against this peculiar media dynamic of crime scene photography, which rests upon the ›magic‹ of the doubled index« (Sykora, *Die Tode der Fotografie I*, 509).

340 Susanne Regener, »Verbrechen, Schönheit, Tod. Tatortfotografien,« *Fotogeschichte. Beiträge zur Geschichte und Ästhetik der Fotografie* 78 (2000), 27–42, here: 38. Cf. also Brittain Bright, »The Transforming Aesthetic of the Crime Scene Photograph: Evidence, News, Fashion, and Art,« *Concentric: Literary and Cultural Studies* 38/1 (2012), 79–102.

But the investigative mode of reading traces that has been activated in terms of reception aesthetics, which can likewise be observed in other popular subgenres of found photography, can also be understood as pointing to the limits of the institutionally organized datafication of photographic practice. The endeavor articulated in the police handbooks of the waning nineteenth century, to confront the continually new chaos of a crime scene with a photo-forensic policy—which included concrete information about the relevant resources, such as the use of ladder stands, or exact specifications on how to sequence framing, advancing from overview to detail shots, and especially the metric tools included in the photographs[341]—is an indirect expression of bureaucratic knowledge about the problematic of photographic data acquisition and processing. In reality, as Bertillon also knew, the intended accuracy of measurement already becomes a problem in the perspectival decisions made by the police photographers on site: it becomes a gateway for aesthetic positions that are difficult for authorities to calculate. The approach of following a wide shot of the crime scene [fig. 1] with a vertical top view of the victim [fig. 6] and finally close-ups of the fatal injuries quickly proved to be a system that was only partly suitable for lab work.

The criminological scientification of forensic image production, which linked questions of perception quite technically to questions of truth, always had an ambivalent data status, even within the institutional regime of truth manifest in crime scene photography. In this sense, the general need to interpret crime scene photography is not so much generated ad hoc by its extra-official distribution as it is exposed—for instance in the form of the question of context and aesthetic value raised by every bureaucratically de-automated reception, as Tim B. Wride has articulated with regard to the LAPD Archive: »One of the problems with thinking about photographs that depict ›the scene of the crime‹ is that it is irresistibly tempting to conflate them with work whose purpose is something other than the dispassionate description of a random occurrence. One always has to ask, at what point does the image cease being about the scene and start being about the photograph.«[342]

From the perspective of the transmission and publishing history of the material, de-datafication initially means that the image is made visible as an image in a different way. After their final storage, forensic photographs—which had until recently belonged to forensic files, to a bureaucratic truth regime, to an instrumental archive—are subject to a process of historicization

341 Cf. Regener, »Verbrechen, Schönheit, Tod,« 29ff.

342 Tim B. Wride, »The Art of the Archive,« in: *Scene of the Crime: Photographs from the LAPD Archive*, New York: Harry N. Abrams, 2004, 20–24, here: 21–22.

that gradually renders them functionless. Only the institutional disinterest in a connection to the present that is expressed by final storage in an archive enables the images to become visible under the contemporary reception contexts of art and pop culture. The substance of the data originally invested in them then potentially takes a back seat to a documentary style laid bare—and opens itself to, for instance, the effects of »studium« and »punctum« so often emphatically described in the discursive history of the medium,[343] which lead to photographic fuzziness and ambiguities being abandoned in favor of subjectively loaded forms of experiencing the image.[344] Without any connection to the task of providing evidence, certain spaces open up for affective and fictional re-evaluations on the one hand, while at the same time there is also the possibility of posing source-critical questions in the interest of historiographic epistemology, rather than merely investigative questions.

II.2.3 Re-Datafication as Historicization

Until recently it was still possible to claim that the crime scene photos of the NYPD Photo Unit only existed in two restrictive transport formats. They circulated either in the temporarily stored, functional form of a forensic instrument under institutional lock and key, or as objects of found photography aesthetics, in whatever way they might be reproduced and appropriated. In both logistical aggregate states, they were not what they primarily are today: historical archival documents that can be distributed as digital files.

The background of their current mobility as digital archival images is a digitization project sponsored by the National Endowment for the Humanities, which since 2015 has taken on the task of gradually transferring the holdings of the NYPD Photo Unit into a publicly accessible web archive. Research revealed that there were many forensic photographs, such as those routinely produced and used between 1914 and 1975, waiting to be rediscovered in the remote basements of various agencies. While Luc Sante in 1992 had to limit himself to a

343 Roland Barthes, *Camera Lucida: Reflections on Photography* [1980], New York: Hill & Wang, 1989, 42f.

344 Cf. Dubois, *Der fotografische Akt*, 95ff. Sean Cubitt has objected to this dominant, ›sentimental‹ interpretive figure of photographic indexicality in view of the historical reality of bureaucratic instrumentalization: »The subjects of nineteenth-century medical, police, and social photographic archives […] were promised whole and discrete moments of indexicality […]. Scientists, police officers, and bureaucrats poring over the files believed that the power over images translated into power over the world« (Sean Cubitt, *The Cinema Effect*, Cambridge, MA: MIT Press, 2004, 40).

period of four years and 1,400 photos, the body currently available encompasses around 180,000 photographs (including mug shots or booking photos as well as photos of paperwork such as pages from files, index cards, and fingerprint documents) from six decades and an estimated 50,000 investigations—chronologically inaugurated by the murder in Old Stone Road. A large portion of these negatives were found not far from Wall Street, and, due to the already deteriorating acetate material, had to be literally dug out with hazmat suits, and in the case of explosive nitrate negatives, disposed of.[345]

The discovery comes at a time when publicly funded digitization projects like this one are generally experiencing a boom. If at the beginning of the 2000s similar undertakings were primarily concerned with strategies for preserving holdings (strategies that were contested, for instance, with regard to questions about the durability of carrier media), by now institutional archives in particular have comprehensively shifted to opening up their holdings through remote access and translating their materials into objects of transmission.[346] Thus, to cite another example, in 2014 Yale University developed the web archive *Photogrammar*, which provides access to the digital holdings of perhaps the most prominent collection of American photographic history: the approximately 170,000 photos from the New Deal photography initiative of the Farm Security Administration (FSA).[347]

The ›ubiquity‹ of the distributed image, to emphasize this point once more, has come about not only because of recent social media practices of everyday communication with digital photographs and the numerous image sensors of the Internet of Things, which will be examined in more detail in Part III, but precisely also thanks to the transcoding of analog archival holdings. Alongside the frequently described unleashing of private collecting activity—»archiving is the new folk art«[348] (Rick Prelinger)—and the exponentiation of commer-

345 Cf. Sante, »A Roomful of Death and Destruction.«

346 On the economy of visibility in this boom, Anthony Hamber notes: »[…] while Web-based digital image databases and catalogues are in some respects rendering ›analogue‹ photographic collections redundant, thereby increasing the threats to their existence, information and communication technology has also acted as a catalyst that has opened up and highlighted the richness and diversity of 19th century photographic collections. Such interest has led to the re-discovery of significant but little known photographic archives ranging from major institutions to individuals« (Anthony Hamber, »Archives, Museums, and Collections of Photographs,« in: John Hannavy (ed.), *Encyclopedia of Nineteenth-Century Photography* (Vol. 1), London: Routledge, 2009, 64–69, here: 64).

347 See: https://photogrammar.org/maps. Cf. Jillian Russo, »Photogrammar. A New Look at New Deal Photography,« *American Quarterly* 68/2 (2016), 439–442.

348 Quoted in Kenneth Goldsmith, »Archiving Is the New Folk Art,« *Harriet Blog*, Poetry Foundation, April 19, 2011, https://www.poetryfoundation.org/harriet-books/2011/04/

cially and promotionally distributed image productivity, retro-converted historical image collections also contribute significantly to the increasing volume of image data transmission.

Digitization fundamentally involves an expanded understanding of archival opening and publicity. Empirical conventions of archival obstruction, of the systematic withdrawal of material—which in earlier times were not only due to legal waiting periods, but also had to do with practical questions of access, of accessibility in physical space, of concrete searchability on site—have less and less of an inhibiting impact on circulation. Once it has been published digitally, visual material is networked in its transcoded translation form, with all the consequences that entails. Once it can be effortlessly copied and sent, it can basically, despite certain barriers of technology and archival policies (copyright, broadband quality, sometimes password protection), be redirected at will into new channels, deposited on cloud servers and local hard drives.[349] The archive's economy of visibility has accordingly shifted on the basis of this altered media-logistical infrastructure: in favor of operative dynamics of data streams flowing out and back instantaneously.

The most recent digital publication of NYPD crime scene photographs, however, can also be interpreted—to a certain degree contrary to the tendencies of leveling and erasing boundaries associated with the shifts outlined here—as the mediated return to their status as documents, once tied to their instrumental purpose. Documents coded in specific institutional ways now circulate

archiving-is-the-new-folk-art. The UbuWeb founder writes: »The advent of digital culture has turned each one of us into an unwitting archivist. From the moment we used the ›save as‹ command when composing electronic documents, our archival impulses began. ›Save as‹ is a command that implies replication; and replication requires more complex archival considerations: where do I store the copy? Where is the original saved? What is the relationship between the two? Do I archive them both or do I delete the original? When our machines become networked, it gets more complicated. When we take that document and email it to a friend or professor, our email program automatically archives a copy of both the email we sent as well as duplicating our attachment and saving it into a ›sent items‹ folder. If that same document is sent to a listserv, then that identical archival process is happening on dozens—perhaps even thousands—of machines, this time archived as a ›received item‹ on each of those email systems. When we, as members of that listserv, open that attachment, we need to decide if—and then where to save it« (ibid.).

349 A typical example would be the Twitter account HistoricPics (whose bio reads: »Sharing the most powerful and entertaining historical photographs ever taken,« @HistoricIG, Twitter, https://twitter.com/HistoricIG). The desire to connect to this stream of visual data, which multiplies and branches out at every second, does not even stop with the CIA, which fills its Flickr photostream, obviously set up for PR purposes, with digitized maps, photographed exhibits from the history of the institution, as well as numerous historical photographs: https://flickr.com/photos/ciagov.

as *historical* documents. In contrast to the photos published in earlier decades via book and exhibition projects, the digital archive is not organized by curatorial gestures of selection and re-contextualization (in some cases also: reinterpreting and inflating), but according to the media-technological logic of a web archive that facilitates access with relatively few requirements, which attaches metadata like finding aids to every image. No editor, no author, no fashion or art photographs, no curatorial program, and no museum framework interferes with the photographs or with their formatting as publicly visible objects. Instead of analog photo-lyricism, digital archival prose now reigns supreme. The »gesture of setting aside«[350] (Michel de Certeau) that co-constitutes the document as such is largely delegated to the pragmatics of the user in this integrated space—»browse all« is written at the entrance, as it were, above the most general search mask of the digital archive.

The photographic image, processed in this way as a networked image, can turn up at any point in visual culture, can be copied, edited, rechanneled, used, and shared. From that point, however, the material also has an institutional address logistically linked to these streams, is associated in the form of its data with a digital location of archival documentation, which equips it with the authenticated references, the legitimacy of an official establishment like that of the NYC Department of Records. Anyone coming across the image or seeking it out can of course block out this provenance, but on the other hand it does not take a great deal of research to come into contact with the pertinent finding aid notations. The digitized image now has an institutional address that circulates along with it—in Suzanne Briet's words we could also say: a computerized »relay«[351]—by means of which the metadata of its archival history becomes fundamentally transportable.

Despite the empirically unmanageable abundance of and a general lack of differentiation in the constantly streaming flow of visual data, a consequential boundary is indeed established, namely the boundary that results from

350 de Certeau, *The Writing of History*, 72. After this he writes: »In reality it [the gesture] consists in producing such documents by dint of copying, transcribing, or photographing these objects, simultaneously changing their locus and their status. This gesture consists in ›isolating‹ a body—as in physics—and ›denaturing‹ things in order to turn them into parts which will fill the lacunae inside an a priori totality« (ibid.).

351 In Briet's essay *Qu'est-ce que la documentation?* (1951), recently rediscovered by information scientists such as Ronald E. Day (and published in English for the first time in 2006), we read the following about the circulation (»chain of production«) of »secondary documents« (catalogues, indexes, etc.): »the relays play the role of distributors of documentation« (Suzanne Briet, *What is Documentation?*, Lanham, MD: Scarecrow Press, 2006, 35; cf. also: Ronald E. Day, »›A Necessity of Our Time‹: Documentation as ›Cultural Technique‹ in *What is Documentation?*,« in: Briet, *What is Documentation?*, 47–64).

the digitized status itself. While the first phase of post-bureaucratic visibility is based on a routine of declassification—which, as shown above, is often discussed as aestheticization but can also be conceived as historicization or even de-datafication, in terms of the institutional value placed on information and utility—with mass web publication, a new data signature, a new archival code is now inscribed.

Re-datafication is fundamentally connected with an optoelectronic process in which a genealogy of distribution history is inscribed, which will be examined in the last section of this chapter. The (retro-)digital datafication of the distributed archival images of the NYPD Photo Unit does not constitute the first time that they have been coded and stored as objects of an institutional archive. This applies less to the forensic crime scene photographs than to those of the records department. As Susanne Regener has shown, at least the »compulsory photographs« used for personal identification were already migrating into criminal-anthropological and medical contexts as early as the nineteenth century.[352] If we return once again to the starting point of these images' archival history, however, we end up at the filing cabinets of Bertillon's department at the Paris Police Headquarters. From this perspective, the current architectures of storage and preservation raise the question of the extent to which current digital archival practice recodes the model of bureaucratically formatted storage, the operational temporary storage of historical police departments.

II.2.4 Old and New Archival Codes

The context just mentioned—we will return to the issue of datafication later—shifts the photographic apparatus as a technology of acquisition into the background, instead focusing on the historicity of the practice of police image archiving. The central question then is not how the material was recorded, but how it was stored and made distributable. Alphonse Bertillon's modernizing project was already fundamentally related to an archival mode of storage,

352 »The photographs of criminals stored in police archives entered into the emerging criminal-anthropological fields, in which the criminal, his appearance, his body, his mind, was interpreted. Parallel to the new technologies in police record keeping, criminology was not constituted as an independent academic discipline at all until the last third of the 19th century. Already familiar photographs from police and prison archives found their way into new archives; in addition, new images were prepared for scientific studies, and publications were increasingly provided with illustrations. In general, we can observe a circulation surrounding the commodity of compulsory photographs« (Regener, *Fotografische Erfassung*, 166).

which, as outlined above, had the task of translating »crammed filing cabinets […] into mobile data.«[353] Even the photographic content in these storage systems is meant to be sorted with mobilization resources. The bureaucratic problem of Herold's BKA that David Gugerli identified with the formulation quoted above—namely the »flood of paper information,« which it sought to alleviate with procedures of electronic data storage and processing—is based, according to Allan Sekula, on Bertillon's understanding of the »institution of the photo archive«:

> If we examine the manner in which photography was made useful by the late-nineteenth-century police […] we need to describe the emergence of a truth-apparatus that cannot be adequately reduced to the optical model provided by the camera. The camera is integrated into a larger ensemble: a bureaucratic-clerical-statistical system of »intelligence.« This system can be described as a sophisticated form of the archive. The central artifact of this system is not the camera but the filing cabinet.[354]

In this database, still manifest as a piece of office furniture, the data of police records (and to a lesser degree also of crime scene forensics) is meant to coalesce in order to make the »archive [forensically productive] as an encyclopedic repository of exchangeable images«,[355] as Sekula writes, referring to Oliver Wendell Holmes's famous metaphor of paper currency. The associated »archival promise« applied not to permanent storage, but to the most logistically effective temporary storage. Data mobility, understood as the prerequisite for epistemic mobility, was not meant to be excluded in favor of models of long-term preservation, which as a rule accompany postulates that involve locking information away. An immediate solution »was frustrated, however, both by the messy contingency of the photograph and by the sheer quantity of images.«[356] In contrast to Holmes's model of a photographic collection—which, as a »comprehensive system of exchanges« of photographic »forms,« was meant to take on the function of a central »Bank of Nature« in order to ensure liquidity and accumulation of the abstract »universal currency« for the sake of infinite circulation[357]—Bertillon was concerned not with relations of equivalency, but with taxonomies and addressabilities. The data mobility

353 Gugerli, *Suchmaschinen*, 55–56.
354 Sekula, »The Body and the Archive,« 16.
355 Ibid., 17.
356 Ibid.
357 Holmes, »The Stereoscope and the Stereograph.«

being sought was based on fixed addresses: the archive was structured as an addressing system. The pioneer of forensic image cataloguing was aiming for an organizational model of places to keep photographs, a model that would definitively preserve the exhibits while at the same time serving as temporary storage optimized for information requests, that is, an arrangement that would allow for the images to be located precisely and processed immediately.

Without an addressing system, there can be no search engine: otherwise, the photographs remain a collection of individual cases, forming a loosely networked, logistically dysfunctional archive of files with no relation to one another. In this context, Sekula compares Bertillon, the »compulsive systematizer,« with the »compulsive quantifier« Francis Galton,[358] whose statistical model for identifying types using the composite photo (on a quest for the average ›criminal skull‹) can therefore be understood as a »sophisticated form of the archive«: »Bertillon sought to embed the photograph in the archive. Galton sought to embed the archive in the photograph.«[359]

The processes of indexing and taxonomic annotation conceived by Bertillon, and the process of file management that these approaches stabilized—implemented in the signaletic note card and the flexibly addressable classification cabinets of the late nineteenth century[360]—were not only intended to organize the rapidly and »chaotically« growing photo archive, but to make it logistically accessible. This »embedding in the archive« did not follow an abstract ideal of storing criminological knowledge, but was conceived for the purpose of delivering stored information for acute criminological objectives.[361] Otherwise, the authorities would have been sitting on securely stored data that could not, however, have been transported into working storage for forensic

358 Cf. also Josh Ellenbogen, *Reasoned and Unreasoned Images: The Photography of Bertillon, Galton and Marey*, University Park, PA: Penn State University Press, 2013.

359 Sekula, »The Body and the Archive,« 55. Susanne Regener has pointed out the transition from archival to typological practices: »The rationality of police criminalistics attempted to see the human being in a new way: by ascertaining individual identification marks, it interprets unique physical qualities, and in archiving the data it works […] with institutional and iconographic methods to produce a criminal type. […] The police photo archive contributes to differentiating the pictorial world in which every portrait is part of a social and moral hierarchy« (Regener, *Fotografische Erfassung*, 161ff.).

360 Ibid., 25.

361 The history of European police photo archives can in some cases be traced back even further: »The criminal justice system began to form archives of photographs as early as the 1840s. In 1843 daguerreotypes were being taken of prisoners in the prison in Brussels and kept by the Sûreté Publique (Criminal Investigation Department). By the 1860s many European states were employing photography to create documentary records of prisoners. Scene of crime photographs were also being widely taken from this time« (Hamber, »Archives, Museums, and Collections of Photographs,« 66).

processing, neither to identify persons nor to provide evidence or investigate crimes.[362]

As W.J.T. Mitchell has argued in his analysis of the Abu Ghraib pictures, today it is the logic of digital metadata that inscribes the principle of archival storage systems directly into photographic data sets:

> Digital photographs unobtrusively and (usually) invisibly carry metadata with them. What Sekula calls the ›truth apparatus‹ of the photographic document is no longer divided between its optical authority and the ›bureaucratic-clerical-statistical system of intelligence that archives the document.‹ It is as if digital images are directly connected to the filing cabinets where they are stored and the retrieval system that makes their circulation possible, carrying their own archiving system with them as part of their automatism.[363]

In the web archive of the NYC Department of Records,[364] network protocols and digital tools determine access to the retro-converted police documents of the city's history. The explicit intention to pass down the holdings of the public institution, the idea of an archivally fixed ›document time‹ that is rendered transferable as an immobilization of time, experiences a corresponding temporalization in media technology. The data objects are mobilized on demand and regenerated time and again at the place of issue according to the quality of the connection, to configurations of software and display. Database management technology thus advances beyond the routines of sorting and issuing that are familiar from historical bureaucracy. The latter is historicized into a trace element that can be interpreted in terms of the genealogy of data images. Documents from secret investigation files that were restrictively distributed behind closed doors become publicly accessible found objects, which can be copied losslessly and disembedded within a ›global archive,‹ redistributed

362 Regener, *Fotografische Erfassung*, 325.

363 W.J.T. Mitchell, *Cloning Terror: The War of Images, 9/11 to the Present*, Chicago: University of Chicago Press, 2011, 124.

364 The holdings of the NYPD Photo Unit are situated among numerous collections from other city agencies: »Dating from the early seventeenth century to the present, the Municipal Archives comprises the largest local government archive in North America. Acquired from city agencies, the Archives hold the records depicting the daily work of city government, including paper records, digital collections, web archives, still and moving images, ledgers and docket books, vital records, cartographic materials, blueprints, and sound recordings« (»About — Organization — Municipal Archives,« NYC Department of Records and Information Services website, https://www1.nyc.gov/site/records/about/municipal-archives.page).

infinitely, and thus also observed, tracked. Behind the archive's metadata functioning as a finding aid, there emerge ever more histories of traces, sedimented as growing data holdings of archive distribution made traceable.

The nineteenth-century model of a visual crime scene *calculation*, which was meant to produce informational values beyond the immediate observable evidence—already contained in Bertillon's photogrammetric utopia of measuring, exploring, and storing photographically acquired photograms so as to be optimized for inquiries—reemerges here as a deferred archival calculus of computer regulated image banks. Recent archival practices as they have developed especially in the last few decades in dealing with digital holdings also reorganize agency history stored in document form into an institutionally recalculated visibility depot. The logistical interface—including its most generally pragmatic functionality, namely »to relate any past document to the present of a here and now«[365]—follows standard protocols. Search terms are crosschecked with deposited keywords tacked on to historical images in the archive's meta-databases as tabular keys, which belong to files that have long since been closed from a forensic perspective.

A search engine algorithm transports such de-bureaucratized material sortations to the user interface, emerges and organizes the agency's visual evidence on demand according to institutionally authorized categories of the relevant archival facility: according to the year, the place, the type of crime, according to photographic agents, formats, carrier material—or, potentially, as is the case in a Digital Humanities project at Yale University: according to a calculation of similarity created by a learning algorithm, which makes it possible to sort photographic collections at the level of the pixel according to »approximate nearest neighbors.«[366] These sequences, generated in a variety of ways, can be read in terms of media historiography, while the documents themselves, in light of their ability to be consulted, are transformed into data-time-sensitive transfer objects, as Jussi Parikka writes: »What this means is a turn from object-centred archiving to objects in the software sense, their searchability and transformation into forms that make them viewable and experiential through encoding, streaming, and other techniques.«[367]

In this way, the historical urban space captured in the medium of crime scene photography can be processed differently than the hypothetical causal chains of a criminal investigation that the forensic desire for elucidation

365 Røssaak, »The Archive in Motion,« 12.

366 Cf. »Neural Neighbors: Pictorial Tropes in the Per Bagge Collection,« Yale Digital Humanities Lab, http://dh.library.yale.edu/projects/bagge.

367 Parikka, *What is Media Archaeology?*, 124.

and observation originally invested in these images might have dictated. History writ large can also be encountered in this archive now and again—for instance, in the form of site survey pictures of the *Hindenburg* airship disaster at Lakehurst in 1937, or via photographs of the Harlem Riots of 1964. But the *longue durée* applies to ordinary urban life, conveyed by way of contingent episodes of its violent disruption: countless pictures of accidents (the archive contains a history of public transit as well as the development of technology and design in the increasingly automotive private transportation) intersect here with series of crime scene picture that are stored according to changing photo-forensic parameters.

Thus the history of New York opens up in the mirror of the various constellations of its crime scenes, which can not only be summoned to displays by remote access, but are also processed by media technology in order to preserve divergent, ›post-forensic‹ evidence. The criminalistic »evidential paradigm«[368] can be used historiographically, redirected from types and circumstances of death that were once under investigation toward, for instance, a history of the décor of urban living rooms, clubs, bar rooms, dance halls—places that inevitably and repeatedly landed in the sights of the NYPD Photo Unit, and that with the passing of time can now be more and mean more than simply the settings for crime scenes, namely as evidence of their own kind: »anonymous«[369] details that were stored incidentally, the much-vaunted surplus of photographic acquisitions, which can now be browsed, zoomed in on according to any given agenda, be it epistemic or even simply photo-fetishistic.[370]

The historicity of police photographic practice can also be brought into the spotlight, and questions such as these can be raised: How did visual signatures and routines of perspective change when magnesium powder no longer served

368 Carlo Ginzburg, *Spurensicherung. Die Wissenschaft auf der Suche nach sich selbst*, Berlin: Wagenbach, 2011.

369 Marc Ferro, »Gibt es eine filmische Sicht der Geschichte?,« in: Rainer Rother (ed.), *Bilder schreiben Geschichte: Der Historiker im Kino*, Berlin: Wagenbach, 1991, 17–36.

370 Luc Sante tends toward both modes: »Every picture is a tableau, complete unto itself. In addition, besides preserving the physical facts of important events and highlighting trends and aberrations in social behavior over the decades, the pictures record innumerable details of the appearance and atmosphere of the city in those decades. From them you can learn what kitchens looked like, how grocery stores decorated their display windows, how much trash accumulated in the street, what hazards attended the operation of open-top flivvers, and all about the wild variety of social clubs, illicit and otherwise, fancy or outré or irredeemably basic, that occupied an awful lot of the real estate in any era. They provide a vital and even visceral link to the city's past, at a time when three-dimensional remnants of that past—buildings, along with their occupants—are being eliminated every day« (Sante, »A Roomful of Death«).

as the basis for flash photography, when ladder stands disappeared, when wide-angle lenses emerged, etc.? Applications such as an integrated media player software render the digitized objects operable on this level of heuristic readings of storage. Anyone who likes can zoom in on a dead person's alarm clock, the cover stories of historical newspapers, markers of an unintentional mise en abyme of photographic recording equipment, or inspect the upper layers of a materially inscribed archival history,[371] which transferred onto the negative as traces of storage and have likewise now been digitized. The algorithms of the digital archive, at least in this sense, still allow us to see the bureaucratic protocols to which the documents owe their histories of origin and transmission.

II.2.5 Transforming Objects

The re-datafication of historical crime scene photos as networked documents of digital image archives begins, in terms of media technology, with optoelectronics: a sensor-based process of capturing data, in which analog light signals are first transformed into an electric charge and then into bit patterns, and thus coded as discrete numerical values. Archived glass negatives are transferred into data images that can be read and distributed by computer technology using a scanning procedure based on a principle that first came into use in this form in 1957, when Russell A. Kirsch used a drum scanner to translate a photograph of his son Walden into an A/D converter product that could be computed in an entirely new way. This legendary digital reproduction, a postage-stamp sized, low resolution data image, contained only 30,976 pixels, but could be copied losslessly from then on.

Analog photographic originals with a carrier medium such as a glass plate, as is the case for the oldest remaining images from the NYPD Photo Unit, are converted into uncompressed archive masters, not all at once but line by line.[372] As a general rule, this process employs flatbed scanners,[373] which essentially

371 Sven Spieker succinctly identifies this dimension of the archive: »[…] namely, that archives do not simply collect the traces of reality, but rather of what has already been collected—that is, in turn, archives« (Spieker, »Die Ver-Ortung des Archivs,« 10).

372 For an example, cf. the guidelines worked out by the SEPIA program (Safeguarding European Photographic Images for Access): *SEPIADES. Recommendations for cataloguing photographic collections*, European Commission on Preservation and Access, Amsterdam, 2003, https://www.ica.org/sites/default/files/WG_2003_PAAG_SEPIADES-Cataloguing-photographic-collections_EN.pdf.

373 The Photography Unit of the NYC Department of Records uses flatbed, transparency, and drum scanners, see: nyc.gov/html/records.

consist of lighting and scanning components. The glass negative lies on a pane of glass, under which light-emitting diodes are typically activated and light-sensitive CCD (charge-coupled device) sensors are moved along the pane,[374] gathering the reflected light and relaying it to an optoelectronic line sensor. The light values derived from the photographic original are imported with the corresponding temporal sequence and written into digital memory banks as bit strings. The distributive agendas and careers of a digital reproduction thus begin with the redistribution of photons in storage technology. Even the initial conversion that transcodes the photographs into transmission objects is itself a time-sensitive process of successive scanning.

After this »transport through highly synchronized circuitry«[375] the historical image exists in a different (additional) storage state that fundamentally reinterprets the dissemination of visual information. The photographic object is transformed into a bitmap, which can be calculated by computers and distributed in various final formats via computer networks according to the stipulations of the relevant transfer protocols. Photographs that have been stored for decades in locked filing cabinets or cellars now have retro-digital doppelgängers with publicly accessible URL addresses. The original maintains its status as an object stored with archival requirements, but after being successfully retro-digitized it is usually moved to the periphery for »collection-economic«[376] reasons, that is, withdrawn from pragmatically accessible segments of the visibility depot. The conversion generates data objects with an

374 On the difference between CCD and CMOS (complementary metal-oxide-semiconductor) sensors, cf. Caplan, *JPEG*, 17ff.

375 Wolfgang Hagen, »Die Entropie der Fotografie. Skizzen zu einer Genealogie der digital-elektronischen Bildaufzeichnung,« in: Hertha Wolf (ed.), *Paradigma Fotografie. Fotokritik am Ende des fotografischen Zeitalters*, Frankfurt am Main: Suhrkamp, 2003, 195–235, here 222. Hagen's precise analysis of the microchip CCD essentially describes a logistical transport chain that leads from the light-sensitive cells of the sensor chips that are read immediately to the comparatively permanent data backup as a digital bitmap. In the process photons are »shipped« as electrons and deposited in »buckets«: »Photons, that is, light, strike tiny semi-conductor arrays arranged next to one another like cells, which are as big (= as incredibly small) as an image pixel that will appear afterwards on the screen or printer. In this tiny area the light causes electrons to migrate to another level of energy, where they are collected by means of a sophisticated circuit logic. The electrons created from light remain there, pixel for pixel, like tiny *electron buckets*. Another trick of circuitry ships the *buckets* to the edge of the chip, where its contents (electrons) are *counted*, that is, measured according to their charge. These measurements can then (but do not have to) be digitally transposed into bit patterns (= numbers)« (ibid.).

376 On the intersections between collection history and economic history—precisely also in view of logistical infrastructures—cf. Nils Güttler, Ina Heumann (eds.), *Sammlungsökonomien*, Berlin: Kadmos, 2016.

affinity for transmission, but at the same time limits access to their originals. The question of the operational implications of remote access therefore also relates to distribution within archival cartography as a whole: »Digitalization puts pressure on the need for the storage of originals, and many objects are sent off to less-expensive locations far from the centres of population. But it also raises the question of the need for originals as, sooner or later, the access or footfall (which is tracked) shows a declining access rate for the original materials. In some cases, the digital versions are considered superior to the originals due to the quality and resolution of the scanning processes.«[377]

From the viewpoint of the archivist, the status of the product of conversion, despite its distributional versatility, remains referentially linked to an object that has usually been taken out of circulation, that is, stored away in the classic sense under lock and key. Elias Kreyenbrühl, who coordinates the digitization of glass negatives for the Basel *Staatsarchiv* (State Archives), has pointed out that the conversion should not be viewed from a one-sided perspective as a tale of loss, in which the visual content that fundamentally cannot be extracted ›losslessly‹ would be as much the focus as the quality of an image carrier medium like a glass plate as a material object, which cannot be converted into bit patterns. Rather, conversion can be seen as an opportunity to reveal certain visual information retro-digitally. Details stored in the grayscale of glass negatives—because they are distinguished by a particularly high range of contrast—can be exposed (for the first time) in an appropriately high-resolution conversion, as can retouching that was performed on the original object at an earlier point in time and is invisible to the naked eye.[378] In order to make such visual information distinguishable, the digitization process has to turn the negative into a positive, which then leads to the problem that the concrete visualization is not only dependent on the (sensor, storage) quality of the data collected by scanner technology, but also on the graphic distribution, the mobilization of the data on the display. In institutional practice this nexus must ultimately be compensated for by creating further archival metadata:

> […] with regard to the distribution of brightness and darkness, we find ourselves today in a similar situation to that of glass plates a hundred years ago. There is more information in the files than can generally be seen. […] On the one hand, we do not know how the images are being represented on screens, and on the other, the image data exceed the

377 Berry, »The Post-Archival Constellation,« 109.

378 Cf. Elias Kreyenbrühl, »Mehr sehen als vor 150 Jahren,« *Blog des Staatsarchivs Basel-Stadt*, Nov. 23, 2015, https://blog.staatsarchiv-bs.ch/mehr-sehen-als-vor-150-jahren/.

> representational capacities of the monitors. There are several ways. The most radical would be to reverse the negative into a positive. […] In this process, the image is given an interpretation. [For] the best compromise between image encoding and reproduction in each case […] we place a grayscale step wedge next to the glass plates, which allows us to take readings of these interpretive manipulations. We even write the density values of the grayscale wedge into the IPTC metadata. With the grayscale wedge the image is reconnected to the real world. What's more: the digital image also documents the condition of the object very precisely. We can measure a brightness value in the image and using the grayscale wedge can read the density of the point on the glass plate at the time of digitization.[379]

In a certain respect this process (»best practice«) is reminiscent of Bertillon's suggestion of making the space within the crime scene photograph calculable by means of the scales photographed as part of the image, insofar as referential tools are stored within the image that are meant to provide the capacity for objective perception, specifically outside the image at a later time in locations where it is consulted for investigative or archival purposes.

By means of documented intermediary steps such as these, professional archival standards explicate that the digitization of photographic holdings transports the originally preserved material into an imaging pipeline consisting of numerous media-technological sequences. An operation that only requires a few seconds in everyday life—in the most casual variations the conversion occurs when a smartphone camera takes a picture of an analog photographic print, saves it in JPEG format, and thus enables it to be distributed immediately via social media[380]—poses a series of new challenges for photographic archival practice beyond access dynamics.

At any rate, the archival codes that are implemented for retro-digitized holdings come into play prior to the modes of datafication, networking, and transmission that become possible in digital image archives—they are already deployed in the moment of conversion, leaving traces of processing by media technologies (whether in the form of sharper detail or through digital artifacts). Photo-forensic undertakings aimed at digital images can also fundamentally

379 Elias Kreyenbrühl, »Die im Dunkeln sieht man nicht,« *Blog des Staatsarchivs Basel-Staat*, Dec. 7, 2015, https://blog.staatsarchiv-bs.ch/digitalisierung-glasplatten-negative/.

380 In institutional archival practices, digital cameras are usually only used when the original photographic material is in such a state that any concrete physical contact with the warm glass pane of a flatbed scanner should be avoided for reasons of preservation.

relate, at later points in time, to the imaging pipeline itself, for instance for purposes of an investigative reverse engineering of manipulative interventions.[381] Following Lorraine Daston, it could be argued at this point that the new archives that emerge in the course of transcoding can in principle also be interrogated for the transcription histories stored within them:

> Long-lived scientific archives straddle media epochs and survive the transition only if the discipline succeeds in transcribing the contents from one medium to another. Astronomy is the paradigm case, with observations stretching in a chain from cuneiform tablets to papyrus rolls to parchment codices to paper books to digital database. Transcription is anything but mechanical: each moment of transcription is an occasion for commensuration of old and new disciplinary standards for reliable data—but also for loss of metadata as well as the detection of old errors or the insinuation of new ones [...]. But the new, handier archives do not supplant the old ones; layers of transcription simply accumulate. [...] At any moment a query could send a researcher burrowing down through the layers of transcription in search of some overlooked detail that has suddenly become crucial. [...] The archive is not and cannot be unchanging. But its usable past must be spliced and respliced with a mutable present in order to guarantee a usable future.[382]

This logic of transcription applies not only to select scientific archives that are continually mobilized through epistemic practices and disciplinary connections, but also to a lesser degree to all other archives that likewise seek a future of continued usage.

Against the backdrop of the increasing risks of invisibility posed by the digital divide over the last few decades, while institutional archives have generally (and often programmatically) shifted toward investing significant resources in digitization projects, programming freely accessible platforms, and connecting their holdings to the general data stream in the form of digital reproductions, research in media studies has shown a new interest in questions of photographic materiality and objectness. The spectrum of difference of the

381 In his book on the fundamentals of photo forensics, Hany Farid writes: »This led us to realize that every digital image has a hidden but discoverable pattern of pixel correlations, and, further, that this pattern will be disturbed if something is added to or removed from the image« (Hany Farid, *Photo Forensics*, Cambridge, MA: MIT Press, 2016, viii).

382 Daston, »Introduction: Third Nature,« 10f.

material turn, postulated against the (alleged) leveling effects of the digital, also encompasses in particular the transport dimension, as Elizabeth Edwards and Janice Hart have noted: »Materiality translates the abstract and representational ›photography‹ into ›photographs‹ as objects that exist in time and space. The possibility of thinking about photographs in this way in part rests on the elemental fact that they are things: ›they are made, used, kept, and stored for specific reasons which do not necessarily co-incide … they can be transported, relocated, dispersed or damaged, torn and cropped […]‹.«[383] The heuristic renunciation of an abstracted »two-dimensional« image content called for here aims at the material nature of »three-dimensional« photographic artifacts on the one hand, and the material reification of the form of transmission on the other, which in part entails expanding the understanding of carrier material. Paper that is merely waste according to conventional interpretive patterns, when transformed into cultural technologies like *cartes de visites* or photo albums, advances to a privileged state as an object of investigation, as does the phenomenal wealth of physical traces that inscribe information about storage times and forms of use into the material. Generally speaking, this discourse is interested in how photographs are handled, how they are used and transported—that is, in the material conditions of photographic circulation as a whole, which is to be understood as the »social biography« of an image: »a specific photographic object, which may or may not be physically modified as it moves through space and time.«[384]

On this view, instead of reducing photographs purely semiotically to extractable image content, to representational systems that take effect in indexical-iconic ways, there ought to be more concern for the historicity of materials that specifically do not carry the visual object neutrally, but rather perform and contextualize it in its specificity of place and time, charging it with tactilities and horizons of meaning, but above all also equipping it with various logistical competencies. A postcard with a photographic motif travels through time and space under different conditions than a photograph that illustrates a newspaper article or one embedded in a family album, which on the one hand entails certain relationships of proximity to other images and conventions of annotation, but on the other hand also points to the displaced transport weight, the recalculation of distributional routines and ranges.

383 Elizabeth Edwards, Janice Hart, »Introduction: Photographs as Objects,« in: Edwards, Hart (eds.), *Photographs Objects Histories: On the Materiality of Images*, London: Routledge, 2004, 1–15, here: 2–3, quoting Nuno Porto.

384 Ibid., 5.

This issue does not first begin with photographic distribution practices. Working on American art history of the eighteenth and nineteenth centuries, Jennifer L. Roberts, who was cited at the beginning of this study, has very precisely shown that questions of transport are specifically suited to highlight the relation between image and materiality: »Although all pictures are in some way material, transit renders their ›thingness‹ conspicuous in a way that the static equilibrium of traditional modes of display cannot approximate. Everything becomes heavier when it has to be picked up and moved. [...] However delicate, weightless, and ephemeral its subject matter, as soon as a painting must be shipped, it must be weighed and measured, packed and labelled. Postage must be paid.«[385]

Against the backdrop of this longstanding narrative of the »material mobility of pictures« (Roberts), the idea of a ›lossless‹ retro-digitization of historical photograph collections is clearly difficult to maintain, even setting aside the question of efficiency in passing down archivally relevant information that is bound to the analog original and for this very reason tends to become invisible in one-dimensional conversion (such as picture margins and frames, or inscriptions on the back, which at best turn up as »content« in meta-databases). Joanna Sassoon has therefore suggested making a detailed record of the various translation achievements of the digitization process and archivally measuring photographic objects precisely in terms of their »irreducible materiality«[386]—not only with additional object descriptions and indexations, but also with the aid of epistemic instruments such as the grayscale step wedge mentioned above—thereby fundamentally construing them at the level of their concrete thingness as complex documents of their technological creation as well as their institutionally organized preservation: »[...] consider a photograph as a multilayered laminated object in which meaning is derived from a symbiotic relationship between materiality, content and context.«[387]

While this discourse plausibly brings out the significance of the material characteristics of photographic objects, it is nevertheless immediately apparent here that the material turn remains exclusively limited to analog photographs. Sassoon does note that the object status, which is to be examined through case-by-case analysis, becomes considerably more complicated in the constitutive technological reproducibility of photographic images, but then

385 Roberts, *Transporting Visions*, 8–9.

386 Assmann, »Archive im Wandel der Mediengeschichte,« 175.

387 Joanna Sassoon, »Photographic Materiality in the Age of Digital Reproduction,« in: Elizabeth Edwards, Janice Hart (eds.), *Photographs Objects Histories: On the Materiality of Images*, London: Routledge, 2004, 196–213, here: 199.

assumes that the pending questions are practically settled by the creation of the digital surrogate (»content-based digital orphans«[388]).

Rather than equating digitization with immaterialization, one ought to consider instead the translation processes and continuities of digital materialities. The data objects created through retro-digitization are also »laminated« plastics, whose logistical transportability depends not only on notoriously opaque algorithms and formats, but also on operationally linked material configurations: »[…] electronic objects are as dependent upon material instantiation as printed books. We access electronic texts and data with machines made of metal, plastic, polymers. Networks composed of fibre optic cables, wires, switches, routers, and hubs enable us to acquire and make available our electronic collections.«[389]

In Estelle Blaschke's examination of the history of the Bettmann Archive[390]—named after its founder Otto Bettmann, who was hired at Berlin's *Staatliche Kunstbibliothek* (the state library of art) in the 1930s, where he began to photograph illustrations and reproductions from art books with a 35mm Leica camera in order to create his own image collection with this transcoded material—the question of the relationship between ›analog‹ and ›digital‹ materiality is broken down in the context of a case study extending to recent modes of photographic conversion and circulation. This occurs above all under the economic conditions of the global trade in images with archival images and stock photography,[391] because the Bettmann Archive, which had grown to over two million photographs over the course of the twentieth century, was taken over by Corbis in 1995.[392] There is also a conversion at the level of the institution: the image archive was transformed into an image database. Since

388 Ibid., 202.

389 Marlene Manoff, »The Materiality of Digital Collections: Theoretical and Historical Perspectives,« *Portal: Libraries and the Academy* 6/3 (2006), 311–325, here: 312. For a thorough discussion of this, cf. Dourish, The *Stuff of Bits*.

390 Estelle Blaschke, *Banking on Images: The Bettmann Archive and Corbis*, Leipzig: Spector Books, 2016.

391 Cf. also Matthias Bruhn, *Bildwirtschaft*, and Paul Frosh, *The Image Factory: Consumer Culture, Photography and the Visual Content Industry*, Oxford: Berg Publishers, 2003, as well as Frosh, »Beyond the Image Bank: Digital Commercial Photography,« in: Martin Lister (ed.), *The Photographic Image in Digital Culture*, London: Routledge, 2013, 131–148.

392 The next step in the advancing centralization of image agencies operating globally was already foreseeable, though not yet finalized, when *Banking on Images* was published. Corbis was a commercial image and media archive founded in 1989 by Bill Gates under the name Interactive Home Systems. It was purchased in January 2016 by Unity Glory International Ltd., a subsidiary of the Visual China Group. Outside of the Chinese market, Getty Images, previously Corbis's main competition, has since been managing the entire holdings, including the Bettman Archive—now with an unchallenged monopoly.

then, the collection has been operated as a »stream of digital images«[393]—as a data stream whose flow is based on technological infrastructures of storage and transmission, which become additional elements of the material archival logistics of the photographic objects that continue to be preserved, rather than replacing these logistics. The analog originals are, on the one hand, deactivated in sub-zero cold storage[394]— that is, they are pulled from circulation and stored long-term in a secure iron ore mine of the Iron Mountain Corporation—but on the other hand they actively secure licensing claims.[395]

This economically rationalized connection between photographic original and digital reproduction, archival depot and database, at once takes on a kind of bridging function between the materialities involved, binding the visibility and accessibility of a data image—commodified in many dimensions not least through the value-added chains of metadata collections—to the archival calculations of an inaccessible storage infrastructure such as that of the Iron Mountain Corporation.[396] The distributed materiality of an image database grounded in a computer network—starting with server farms, fiber optic cables, screen technologies—extends to the use of energy and raw materials, which routinely accumulate with the conservational storage and management of photographic objects.

393 Blaschke, *Banking on Images*, 165.

394 Ibid., 183ff.

395 »It is important to note that the analog carrier is not discarded; rather, it remains in the collection and is marked with a barcode by which the complete set of original and added metadata becomes machine-readable. The analog negative or print serves as a guarantee in a double sense: On the one hand, it is considered the source, and can be re-scanned if the digital data is damaged or if future quality standards require it. On the other hand, in most cases the analog photograph functions as the essential rights certificate, stamped or marked on the reverse side of the print or envelope« (ibid., 173–174).

396 Estelle Blaschke recognizes the continued presence of a »dream of immateriality« as a discursive figure in the history of photography that is put forward time and again, with the first paradigmatic formulation probably stemming from Oliver Wendell Holmes. Like in Holmes's idea that »form is […] divorced from matter« (Holmes, »The Stereoscope and the Stereograph,« 30), digitization was often understood as a fundamental disengagement of the medium from the requirements of its carrier material: as upholding the promise of ›pure information,‹ to be reproduced and distributed at will, which enticed companies like Corbis and Getty—in the additional erroneous belief that digital content, and not merely data, would become the central currency of the looming information economy—to enter the market of image archives in the first place. This led to high investment and storage costs (scanners, cold storage facilities, etc.) and of course also to feedback effects of digital materialities, starting with the need for cold storage of data server farms and the necessity of regular data migration for purposes of long-term security (cf. Blaschke, *Banking on Images*, 161ff. and 179ff.).

In this context the scanner appears as a sort of hinge technology that continually enriches the digital stream of image data with newly datafied historical collections, accessible in new ways—an influx that is prepared line by line in analog photo archives. But this influx, operationalized via an initial A/D conversion process, also points to a media-archeological trail, which will be addressed more thoroughly in the last section of this chapter. This trail links the line-reading, data-writing apparatus that makes it possible to feed historical photographs into today's networks as digital objects, with media-technological prehistories of an image fragmented for purposes of distribution, which was also of interest to the police early on.

II.2.6 Discrete Distribution

At the second international police congress, held in September 1926 in Weimar Republic Berlin, the various agency representatives gathered there had invited the physics professor Arthur Korn, a researcher and inventor who was already well-established even beyond professional circles. His lecture, published in a revised and expanded form the following year as »Wissenschaftliche Veröffentlichung des Kriminalistischen Laboratoriums der Polizeidirektion Wien« [»Scientific Publication of the Vienna Police Headquarters' Criminological Laboratory«], documents criminologists' need for advanced input in media technology. Under the title »Die Bildtelegraphie im Dienste der Polizei« [»Phototelegraphy in the Service of the Police«], Korn informed the audience about the current state of his experiments, outlined the effectiveness of this medium, and provided a comprehensive review of the history of telegraphic image transmission. This history began with some patent specifications submitted in 1843 by the Scottish clockmaker Alexander Bain and an apparatus that the English physicist Frederick Collier Bakewell made reality in 1847: the first fully functional (electro-chemical) image telegraph. At the very beginning of his lecture, Korn clarified why the police ought to be interested in this technological evolution:

> We are all aware of the fact that phototelegraphy must play a very important role once it is taken into the service of the police. The postal service is much too slow for intelligence services and police records departments, and even the airplane cannot compete with an electrical current or electrical waves in the aether. […] An objective presentation of the methods and results that have already been achieved, and are understood to be constantly advancing, will show that the police can no longer ignore this

> important communication medium, that an international organization of phototelegraphy for the purposes of police work must be undertaken very soon.[397]

At the congress, Korn, who a few years earlier had written the first (and until the beginning of the twenty-first century, the only) comprehensive media history of phototelegraphy,[398] spun a tale of progress heading toward a vision of »practical electric televiewing,«[399] a tale that was plausible in view of the growth rate of transmission speed recorded to date. While the transfer of a portrait photograph over the telephone loop Munich-Nuremberg-Munich still took 42 minutes in 1904, three years later it was possible to achieve significantly better results at 12 and sometimes even 6 minutes, which the scientist substantiated with a number: »40,000–50,000 picture elements« could be telegraphed in these few minutes, »which is sufficient to transfer portraits with very good similarity«; however: »for transferring groups and landscapes we were already at our limits.«[400]

The time it takes to transmit messages, as Korn showed his listeners, exists in a state of temporal competition. This new time, which must be reckoned with from a criminological point of view, results from the increased mobility of subjects addressed by police records departments. If the agencies want to gain advantages here, they must modernize their media logistics, overlaying the existing system of accelerated personal transport with an efficient network of data exchange, whose channels would also specifically facilitate an instrumental circulation of images:

> Already in 1908 the police achieved success. A jewel thief fleeing from Paris to London was identified with the help of a picture transmitted telegraphically from Paris to London. The picture was reproduced in London in the large run of the ›Daily Mirror,‹ in close to a million copies, and an innkeeper was able attest that the wanted man had spent the night in his inn, a statement that led to the identification of the criminal.[401]

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397 Arthur Korn, *Die Bildtelegraphie im Dienste der Polizei* (Wissenschaftliche Veröffentlichung des Kriminalistischen Laboratoriums der Polizeidirektion Wien, Vol. 6), Graz: Mosers, 1927, 1.

398 Arthur Korn, *Die Bildtelegraphie*, Berlin: De Gruyter, 1923. Cf. Albert Kümmel-Schnur, Christian Kassung, foreword to Kümmel-Schnur, Kassung (eds.), *Bildtelegraphie. Eine Mediengeschichte in Patenten (1840–1930)*, Bielefeld: Transcript, 2012, 7–12.

399 Korn, *Die Bildtelegraphie im Dienste der Polizei*, 56.

400 Ibid., 17.

401 Ibid., 19.

For Korn, the »quite extraordinarily rapid transmission« represents a »sine qua non« for phototelegraphy in general.[402] The present and future of electrical lines should thus be separated from the history of those postal services that had burdened picture messages with considerable transport and temporary storage times as they passed through space, from the stagecoach and the carrier pigeon to the airmail plane. Now there was a utopia of instantaneous transmission on the horizon. The protracted delivery time for letters should now become signal transit time, and thus as close to ›timeless‹ as possible. This is ultimately still time-sensitive,[403] as it is tied to the transport capacities of the channel. But what telegraphy does change is the calculus of communication. The economization of channels in phototelegraphy entails that the time of transmission itself now determines the cost of distributing an image.[404]

This spin—Korn was addressing potential buyers for his inventions, who had previously been primarily newspaper and magazine publishers[405]—reveals a certain dynamic, even if, in the example cited here, the »telegraphing speed,« which competes effortlessly[406] with the cross-border movements of

402 Ibid., 36.

403 »Processing and transmitting are operations, and operations take time, and therefore cannot operate outside of time, in pure synchrony. At the same time, however, they are—obviously—the enemies of time insofar as they constantly attempt to minimize their own duration. Media history worked hard to achieve in the telegraph a transmission that is timeless within pragmatic limits« (Winkler, *Prozessieren*, 198).

404 Marius Hug has made the following calculations about this economy: »At the beginning of the 20th century we were still a world away from flat rates throughout Europe. Usage of a telephone line for 45 minutes was anything but a cheap undertaking. Starting on April 1, 1900, a new pricing system charged 100 pfennigs per three-minute unit for a long-distance call over 500 km. The 1,500 pfennigs this would amount to for a 45-minute call would equate to 66 euro today« (Marius Hug, »Die Übertragung wagen. Der Patentanmelder Arthur Korn,« in: Albert Kümmel-Schnur, Christian Kassung (eds.), *Bildtelegraphie. Eine Mediengeschichte in Patenten (1840–1930)*, Bielefeld: Transcript, 2012, 211–231, here: 212).

405 For a cultural history perspective on phototelegraphic practices in the press between the wars, cf. Myriam Chermette, »The Remote Transmission of Images: A Cultural Chronology of Telephotography in the French Press,« *Études photographiques* 29 (2012), http://journals.openedition.org/etudesphotographiques/3484.

406 Korn, *Die Bildtelegraphie im Dienste der Polizei*, 36. Bernhard Siegert cites a structurally similar example from 1845, in which the competitively traveling message did not yet take the form of an image: »Because dispatch operations remain in the stagecoach era, however, the sender could now overtake letters during travel for the first time. ›Travelers reached their destination earlier than letters sent there at the same time—a circumstance that was unthinkable at the time and that was deeply regretted by the General Post Office.‹ The police also had cause to regret this circumstance. The railway carried fugitive criminals more quickly than any wanted notice or poster—it established a ›lawless speed zone.‹ It was therefore not by chance that the medium of the electric telegraph with its pseudo-instantaneous transmission speed was first used by railway companies. For no

the wanted criminal, functions as only the first link in a transport chain that does not become forensically effective until the next step—by distributing the shipped goods in space: on the printing paper of a tabloid magazine, whose individual pages are folded together and in turn conventionally distributed by post throughout the country.

According to the most general definition, phototelegraphic transmission organizes a technological »transfer [...] of information of any nature, distributed two-dimensionally,«[407] which is thereby not only delivered more quickly, but also becomes more versatile in its distribution. The reason for this—the details and consequences of which will be discussed shortly—lies in a conversion process that is compatible with both telegraphic and print technology, a process that an analog photograph must undergo in order to be distributable in this way at all: »The images received in this telautographic raster method are black and white images, which are readily suited for printing with the rotary press, with no further rasterization being necessary.«[408]

Just as in Bertillon's model of the operational photo archive, the »telegraphic wanted poster« is first and foremost a matter of visual data mobilized for police identification purposes: a matter of a comparison with photographic holdings—be that in the form of portraits, which store a »good similarity,« or by means of the »telegraphic identification by fingerprints,« which was gaining acceptance and was meant to protect »the innocent from false suspicions more quickly thanks to optimized transmission.«[409] However, according to Korn, the systemized identification of persons using photography, which had been in place since the 1880s, is not the only application for telegraphic image transport: »The telegraphic transfer of summaries of evidence, views of objects found at the scene of a crime, can occasionally be useful.«[410]

Throughout his address, Korn appeals to a desire for distribution on the part of the police, which is based on the insight that criminological advantages

other time period could the telegraph be as important as it was for the era ›which had seen an almost immeasurable multiplication and acceleration of passenger traffic due to the invention of the railway.‹ In 1845 the murderer Towell, fleeing by train from Slough to Paddington, was able to be arrested when he arrived in London because his ›telegraphic signalment‹ overtook him on the way« (Bernhard Siegert, »›Barockes Felsgesims‹ ohne Grund und Boden. Historismus als Epoche der Nachrichtenmedien (Eisenbahnen, Post und Telegrafie) um 1850/60,« in: Christoph Neubert, Gabriele Schabacher (eds.), *Verkehrsgeschichte und Kulturwissenschaft. Analysen an der Schnittstelle von Technik, Kultur und Medien*, Bielefeld: Transcript, 2012, 73–92, here: 82).

407 Kümmel-Schnur, Kassung, foreword to *Bildtelegraphie*, 7.

408 Korn, *Die Bildtelegraphie im Dienste der Polizei*, 31.

409 Ibid., 46.

410 Ibid., 47.

can be derived from carefully archived, catalogued visual information consolidated through measurement values and metadata sheets only if the filing systems maintain a close link to the working storage of concrete investigations. Moreover, telegraphy would be the up-to-date channel for such data circulation—Sekula speaks here of »a race against opponents who likewise avail themselves of the devices of modernity« and thus first put pressure on Bertillon's »archival project« in terms of transmission technology, then set it in motion[411]— because, as Korn continues, additional agency-specific functions such as the desire for »confidentiality« could be implemented here as well:

> Non-professionals generally cannot intercept the message because they are not in possession of the necessary equipment for this purpose; but even if they did expend the resources necessary for this, they would not get any results, if the photographic transmissions were to be made using specially pre-arranged synchronism; sending the telegram in code would then be entirely unnecessary.[412]

Photographs, archives, and telegraphy come together in this model to engage stored content with media-technological dynamics of instrumental transmissibility. Information that is not compatible with the most advanced distribution channels can continue to be acquired and archived, but it is inevitably devalued if it cannot be mobilized or effectively cached. In a certain sense, phototelegraphic devices and processes bring about the first context of media functionality in which the photographic image is subjected to an operational analysis that is paradigmatically programmed for distribution. The standards of media logistics and perception theory begin to converge fundamentally. The photograph is dissected into »visual elements,« the transmission channel is determined by a perceptual calculus. By linking up with phototelegraphy, the police photo archive is literally electrified. From that point on, the visual material of the institution no longer circulates exclusively by post, in file circulation paths tied to a location, but rather by means of a cable system that immediately transfers energy and information »into the distance.« Viewed in this way, the history of streaming visual archives begins with the electrification of its media technology—in Alexander Baines's formulation: »an arrangement for taking copies of surfaces at distant places by means of electricity.«[413]

411 Sekula, »The Body and the Archive«, 33.

412 Korn, *Die Bildtelegraphie im Dienste der Polizei*, 49.

413 Alexander Bain, *Electric Time Pieces and Telegraphs*, London: George E. Eyre and William Spottiswoode, 1856.

The recently (re-)awakened interest within media and cultural studies in the history of the various phototelegraphic apparatuses, patents, and operations[414] is related in part to the discipline's interest in attaining a critical distance from the digital present, guided by media archaeology, with a focus on infrastructural prehistories and early histories connected with the expansion of the telegraphic communication network, which Tom Standage has called »the Victorian Internet.«[415] On this level, the continuities that can be established throughout technological revolutions and surges of innovation are essentially of a media-logistical nature, as has been shown by Ned Rossiter—who reads the current cartography of networked data centers through the lens of its geopolitical historicity, positioning telegraphy as a foundational technology of an »imperial infrastructure«[416]—as well as Nicole Starosielski in her study on the transpacific cable network.[417] Precisely in a historical moment that seems to be defined by miniaturized processing units and the presumed disappearance or invisibility of the cable,[418] by »everyware«[419] and »wirelessness,«[420] the discourse on the history of infrastructure examines telegraphy as a media technology with a multitude of connections with both the geographic and material distribution of present-day communication networks.

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414 In addition to Kümmel-Schnur, Kassung, *Bildtelegraphie*, see also Julia Zons, *Casellis Pantelegraph. Geschichte eines vergessenen Mediums*, Bielefeld: Transcript, 2015, and Franz Pichler, *Elektrische Bilder aus der Ferne. Technische Entwicklung von Bildtelegraphie und Fernsehen bis zum Jahre 1939*, Linz: Universitätsverlag Rudolf Trauner, 2010.

415 Tom Standage, *The Victorian Internet: The Remarkable Story of the Telegraph and the Nineteenth Century's On-line Pioneers*, London: Walker & Company, 1998.

416 Cf. Rossiter, *Software, Infrastructure, Labor*, 147ff.

417 »Moving from the techniques of the telegraph era, through those of the coaxial period, and to those of today's fiber-optic networks, this chapter describes how investments in cabled environments have shaped the topographies of three generations of transpacific cables […]. The global telegraph network, constructed in the second half of the nineteenth century, drew support from colonial networks and pioneered the use of the ocean as a layer of insulation. The reinvention of cable technologies after World War II involved negotiations between existing routes of empire, emerging forces of infrastructural decentralization, and a new club system of cable laying […]. Today, the lines along which the Internet flows evidence a similar push and pull: deregulation and privatization have helped pioneer a new cable geography, which nonetheless is layered into a geopolitical matrix of preexisting colonial and national routes« (Starosielski, *The Undersea Network*, 30).

418 See footnotes 96 and 99.

419 Adam Greenfield, *Everyware: The Dawning Age of Ubiquitous Computation*, London: Pearson Education, 2006.

420 Adrian Mackenzie, *Wirelessness. Radical Empiricism in Network Cultures*, Cambridge, MA: MIT Press, 2010.

Not least, this perspective enables the narration of a genealogy of ›ubiquitous computation,‹ as Florian Sprenger and Daniel Gethman suggest in their media history of transmission. The cable is understood here as a »medium that transmits nothing other than an effect.«[421] Accordingly, the telegraph is the first »cable experimental system« to open up the world, a system which, starting with wireless telegraphy—with a significant contribution by Arthur Korn in the Lorenz–Korn image transmission system, released in its provisionally complete version in 1926 after initial test runs in 1907[422]—has tended to withdraw rather than disappear entirely in favor of a logic of dynamically positioned addressing: »Transmission has become the permanent state of reception. Reception no longer means the presence of a cable end. This end has instead merged with the address, which can now come into being because frequencies match.«[423]

The media-logistical connection between telegraphically transmitted images and those transferred via computer networks, however, is not limited to shared infrastructural conditions and their prehistories. With phototelegraphy, a form of the digital image emerges that shares with the data image streams of the twenty-first century the basic principle of discretization. This principle is already evident in the mosaic images or mosaicked surfaces of antiquity, but it is decidedly reformatted by telegraphy. The picture elements here are not discretized in just any way, but specifically with regard to their technological transmissibility. Dismantling and reconstructing the image follows a logistical logic that takes account of channel conditions, capacities, and compression possibilities. The image is broken apart in order to become distributable.

The digital reproductions of the NYPD Photo Unit images now circulating in JPEG format are genealogically linked to the photographic images that Arthur Korn was transcoding in 1902 into intermediate or »sending plates«[424] in order

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421 Daniel Gethmann, Florian Sprenger, *Die Enden des Kabels. Eine kleine Mediengeschichte der Übertragung*, Berlin: Kadmos, 2014, 21 and 12.

422 Cf. Korn, *Die Bildtelegraphie im Dienste der Polizei*, 35ff., and Pichler, *Elektrische Bilder aus der Ferne*, 10f. Already in 1928 there was a model of the Lorenz–Korn image transmission system at the Berlin Police Department: the receiving system in Reinickendorf, the sending system in Adlershof (cf. Christian Kassung, Franz Pichler, »Die Übertragung von Bildern in die Ferne. Erfindungen von Arthur Korn,« in: Albert Kümmel-Schnur, Christian Kassung (eds.), *Bildtelegraphie. Eine Mediengeschichte in Patenten (1840–1930)*, Bielefeld: Transcript, 2012, 101–121, here: 112ff.).

423 Gethmann, Sprenger, *Die Enden des Kabels*, 105.

424 Korn informed his listeners at the Berlin Police Congress in detail about this intermediate technological step as well: »Of particular significance for the application of telautographic methods, alongside the method of photoelectric cells, is the fact that we can also transfer photographs by means of these methods. In order to do so, however, the

to telegraph photographic raster images throughout Europe for the first time. Lines of development and shared fundamental principles lead from the historical »analog-digital mélange«[425] of phototelegraphy through the fax machine and McLuhan's »mosaic TV«[426] to the scanned or computer-generated streaming image of the present. Continuous, smooth, analog visual surfaces are fragmented and encoded according to structurally similar principles in order to be transported discretely, dot by dot, line by line through the transfer channel and then decoded, made visible in distant places as visual information surfaces. The underlying blueprint of technological image transmission can be found subsequent to telegraphic conversion in many other configurations of the distributed image, as Albert Kümmel asserts:

> And yet, under the premise that radar technology is found between the pixels of the television and the graphic surfaces of computer screens, it is also obvious that the raster images of early television should be included in the history of the digitization of images and thus in the history of the analog/digital distinction. The reason for this is self-evident: digital images, whatever else they may be, are images made up of discrete elements, images cut up into rows and columns for the purpose of literally pinpointing accurate transferability.[427]

The history of fragmented, rasterized, specifically distributable »images in rows and columns«—a history exceedingly complex in its technical details—has been examined in media theory for several years as the early history of digital image technologies and »bitmapped graphics.«[428] Further expanding

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photograph first has to be converted into a black-and-white image, and just like for plates of the rotary press and many other purposes of reproduction technology, this conversion takes place by means of the autotype procedure. The photograph is copied onto a layer of chrome gelatine by means of a glass raster—a glass plate covered in many parallel lines arranged in close proximity to one another—which for our purposes is applied to a metal plate. [...] Since the layer of chrome gelatine is nonconductive for electrical current, this produces a black-and-white print, which can be scanned in the ordinary way by the tracer pin of the telautograph encoder« (Korn, *Die Bildtelegraphie im Dienste der Polizei*, 31).

425 Kassung, Pichler, »Die Übertragung von Bildern in die Ferne,« 108.

426 Marshall McLuhan, *Understanding Media: The Extensions of Man* [1964], Cambridge, MA: MIT Press, 1994, 161.

427 Albert Kümmel, »Ferne Bilder, so nah (Deutschland 1926),« in: Jens Schröter, Alexander Böhnke (eds.), *Analog/Digital — Opposition oder Kontinuum. Zur Theorie und Geschichte einer Unterscheidung*, Bielefeld: Transcript, 2004, 269–294, here: 271. Cf. also Jens Schröter, »Analog/Digital — Opposition oder Kontinuum?,« in: ibid., 7–32.

428 A key text here is: Peter Berz, »Bitmapped Graphics,« in: Axel Volmar (ed.), *Zeitkritische Medien*, Berlin: Kadmos, 2009, 127–154.

the time frame of this history, Birgit Schneider has suggested beginning with woven »textile images,« since rasterization techniques are already operative in the practice of textile processing, and, furthermore, Joseph-Marie Jacquard's punched card mechanical loom bears a resemblance to Charles Babbage's analytical engine, which »weaves algebraic patterns, just like the Jacquard loom weaves flowers and leaves.«[429] The conversion of an analog model, which is calculated according to earlier models of perceptual coding—as a quantity of picture elements at a suitable resolution[430]—thus results in a »picture code,« which Jacquard's punched card enables to be stored beyond the moment of transfer. The difference to the digital images of the present is not found in the fact of detaching visual information from a particular physical carrier material, but essentially lies in the possibility of controlling this information precisely, in terms of discrete values and mediated by software technology. The newest discrete picture elements—known as pixels—are directly accessible for mathematical operations and are furthermore temporalized as »dynamic pictures«[431] that can be sent bit for bit. And even if there is no transfer via a computer network, the elements are entangled in permanent transport processes that assemble and disassemble the image, they are constantly distributed to the screen anew: »Pictures are now unfolded temporally, like music.«[432]

It is with phototelegraphy, the first »radical discretization of images,«[433] that information-technological distribution calculations begin to intervene in photography with a lasting impact, restructuring its epistemology and visibility in

429 Peter Berz, Birgit Schneider, »Bildtexturen. Punkte, Zeilen, Spalten,« in: Sabine Flach, Christoph Tholen (eds.), *Intervalle 5. Schriften zur Kulturforschung. Mimetische Differenzen. Der Spielraum der Medien zwischen Abbildung und Nachbildung*, Kassel: Kassel University Press, 2002, 181–219, here: 197. Cf. also Birgit Schneider, *Textiles Prozessieren. Eine Geschichte der Lochkartenweberei*, Berlin: Diaphanes, 2007.

430 The calculation, as Jonathan Sterne writes in view of the halftone rasterization used in printing technology, has the goal of increasing the speed and volume of image circulation through compression operations: »As halftones became cheaper and more plentiful, images could compete with words for priority on the printed page. Composed of hundreds of tiny dots that vary in size, shape, or layout, halftones rely on readers' eyes blurring the dots into a continuous image at a distance from the page. A multiple-halftone process facilitated color prints of photographs, and halftones share a technical logic with facsimile transmission and pixel-based display technologies. Besides suggesting a common material basis for paper- and screen-based media, halftone history illustrates the way that even something as light and portable as paper can be made more dense, more available to new kinds of content through compression techniques« (Sterne, »Compression,« 46).

431 Berz, Schneider, »Bildtexturen,« 201.

432 Ernst, »Jenseits der AV-Archive,« 89.

433 Berz, Schneider, »Bildtexturen,« 209.

terms of transfer analysis and media logistics: »Where telegraphy moves into the image and the image into telegraphy, there begins a consideration images in terms of information theory.«[434] The resulting chain of operations goes through numerous refinements and optimizations—but the framework, the specific connection between image conversion and image transfer, becomes stabilized over the long term. The photographic original is fragmented through a scanning process, coded as a raster image, temporarily stored (initially on perforated, machine-encoded punch tapes) and finally—»with an electrical current or the electrical waves in the aether« (Korn)—distributed point for point. At the receiving end the reconstruction work initiated during transmission ultimately results in the storage form of a copy written remotely. For Geoffrey Batchen, this »interaction of photography, telegraphy, and computing« begins with Shelford Bidwell's telautograph device (1881): »By the 1880s, photographic images were being converted into numerical data, transmitted by binary electrical impulses to another place, and reconstituted as images.«[435]

The intermediate plate method[436] developed by Arthur Korn represents a turning point in the history of telegraphy, as this method is usually understood as »the first purely digital process of image transmission.«[437] While Christian Kassung and Franz Pichler see the intermediate storage model of the telegraphic raster image realized in this method primarily as relieving a temporal burden,[438] Peter Berz emphasizes that images in rows and columns have been

434 Ibid.

435 Geoffrey Batchen, »Electricity Made Visible,« in: Wendy Hui Kyong Chun, Thomas Keenan (eds.), *New Media, Old Media: A History and Theory Reader*, New York: Routledge, 2006, 27–44, here: 39.

436 The intermediate plate method replaces the conversion of brightness values with analog electric voltage values according to the so-called selenium method (cf. Pichler, *Elektrische Bilder aus der Ferne*, 8).

437 Jens Schröter, »Das Ende der Welt. Analoge und digitale Bilder — mehr oder weniger ›Realität‹?,« in: Schröter, Alexander Böhnke (eds.), *Analog/Digital — Opposition oder Kontinuum. Zur Theorie und Geschichte einer Unterscheidung*, Bielefeld: Transcript, 2004, 335–354, here: 357. Albert Kümmel clarifies at this point: »The doubled transcription of the intermediate plate is a clear step in the direction of what will be understood as ›digitality‹ under computer conditions, not only in terms of the genuine discreteness of the visual elements, but above all due to the possibility of localizing them clearly on the surface—first line, third A; fifth line, second Z. The visual elements of the intermediate plate are not only *discrete*, but also *coded* independently of media« (Kümmel, »Ferne Bilder,« 281).

438 »As complicated as the translation process of the intermediate plate is, the advantages of a digital data carrier are all the more striking. First, the synchronization between sender and receiver, which is complex and always prone to interference, is no longer required due to the transfer being stored. That which exists as a stored message has no need for the time-sensitive operations of messengers. Second, and for this reason, long stretches

inevitably embedded in time-sensitive processes since the advent of weaving technology:

> The images in rows and columns used by computers are […] not only fragmented into individual spatial elements, but also into temporal elements. A pixel is a point in space and in time. […] Rows and columns should be conceived in time. Where it is the time of preparation and processing that counts in weaving—feeding in data or punching, scanning and transporting punched cards—and in phototelegraphy the time of transmission counts and costs, in digital raster graphics what counts is the time of constructing the image itself every second.[439]

How many elements constitutively belong to an image *as image*, which ones are dispensable, where blank spaces appear as perceptually justifiable, how relationships and distances between the units are to be defined—all this is negotiated for the first time in view of distribution processes with phototelegraphy.[440] A coordinate system is developed that assigns exact locations to discrete points on a surface. These points cannot yet be addressed individually by mathematical operations or manipulated by algorithms, but they can be discretely relocated, distributed and reproduced as a ›similar‹ image over great spatial distances. This only works, however, if the picture elements are informed about their position: »How many neighbors does a pixel have? That is, a point that is a pixel must […] have precisely defined neighbors, after all. If it suddenly has different neighbors due to a shifting of rows, the picture is no longer the same picture. A pixel's information includes not only its color and absolute position, but above all its position relative to all the other points of the picture.«[441]

The long-distance effect of position maps that are informed accordingly is not without consequences for the history of images on various levels. Expectations for circulation are inscribed in transport goods, increasingly calculating in terms of the distribution economy. Rough rasters thus reduce the necessary telegraphic signals and decrease transmission costs. And this also

of cable do not present a problem, since the signals do not need to be amplified, but at best checked, for instance by sending along checksums. The intermediate plate method allows for the transfer of images ›at *any time* and with *any speed*‹« (Kassung, Pichler, »Die Übertragung von Bildern in die Ferne,« 110).

439 Berz, »Bitmapped Graphics,« 145.

440 Though it should be noted that the first telegraphically transmitted images were not photographs, but text images such as handwriting (cf. Zons, *Casellis Pantelegraph*, 57).

441 Berz, Schneider, »Bildtexturen,« 207.

benefits transport speed: to a certain extent, the distributional disadvantages that emerged for visual signal systems and forms of communication prior to the arrival of phototelegraphic processes are offset.[442] Resolutions and cable capacities fluctuate then as now—the image adapts. What is distributed is what the channel being used yields, what the fee system allows. A principle that extends from early telegraphy and the television image with its »low degree of data«[443] to the adaptive streaming of the present day. But only here does the raster become dynamic, searching the channel for its data performance potential, not in anticipation, but synchronously with the transmission. The pixilation that made the picture unrecognizable as a picture and the pixel raster that, for the sake of the transparent transfer of visual information, cannot be perceived—these are the diametrical poles of the concurrent spectrum of flexible compression.

From this perspective, the history of the technologically distributed image follows from phototelegraphy to the digital reproduction, from intermediary plates to image data formats, from the telegraph to the computer network of an operational sequence made up of scanning (if there is an analog original), fragmentation, transfer, and recombination. The corresponding connecting lines can undoubtedly be drawn in very different ways through the space of media history. One short-range description reads: The forensic evidence described at the beginning of this chapter, secured photographically by the NYPD Photo Unit in 1915 during its operation in the wooden shack of a murdered woman named Marion and later stored as glass negatives in the police archive, circulates today on the basis of a retro-conversion mediated by scanner technology, a process whose principles are linked with Arthur Korn's

442 Jennifer L. Roberts understands telegraphy in this sense as a »truly cosmic split in the mobility of media« (although she does not mention phototelegraphy): »Prior to the telegraph, the words *transportation* and *communication* were effectively synonymous; afterward, for the first time, the process of long-distance communication was dissociated from the physical movement of material bodies, and the two concepts diverged. [...] While the apparatus could translate and transmit verbal inscriptions instantaneously and nearly immaterially over vast distances, it was impotent in the face of visual inscriptions—it could not cleave their informatic qualities from their material qualities; it could not translate the visual field into its ribbons of code. Prior to the telegraph, pictures and letters had moved along the same routes, at the same speeds. With the telegraphic transformation, however, images were, for all practical purposes, left behind. Rather than engaging the visible, telegraphy abandoned it« (Jennifer L. Roberts, »Post-telegraphic Pictures: Asher B. Durand and the Nonconducting Image,« *Grey Room* 48 (Summer 2012), 12–35, here: 30 and 13–14.).

443 McLuhan, *Understanding Media*, 161.

research on telegraphic raster image transport, in terms of both the history of infrastructure and the technology of the digital image. The historicity, the stored informational content of these police images includes not only the inscribed archival rules and regulations, the cycles of de-datafication and datafication, but also a media-historical resonant space full of transcription history. The glass negative shines through in the digital reproduction, telegraphic knowledge is hidden within the scanner, the raster process writes the history of distribution.

Since that time, distribution has counted on discretization: in picture elements and data packets. It is media-logistical parameters that, in the output of phototelegraphy, define what is coded as visual information in a photographic surface, and accordingly, what can be converted or compressed. In the model of almost any fine-grained or coarse-grained rasterization, the photographic image becomes an adaptive transport object that can be disassembled during the transmission process according to the requirements of the channel: in terms of media history, first »in a linear stream of electrical impulses,«[444] and later as a datagram series distributed by computer networks that is reconstituted according to protocol at the end of the wire, where the requesting client is waiting.

The telegraphic capture of a photograph turns it into a signal. The criteria for its communicative suitability are prescribed by the channel. Nonetheless, the postal »logic of delivery«[445] is not entirely encompassed by the digital process of transmission, by information-technological processing, but rather also entails that the photograph can be temporarily deposited in a new way, that it begins to lead a coded existence in intermediate storage on paper tapes

444 Batchen, »Electricity Made Visible,« 39.

445 Winkler, *Prozessieren*, 279. Winkler here proposes the thesis that the computer is a »legitimate and direct offshoot of the telegraph,« since the processes internal to the computer can be understood as transport operations between hard drive, working memory, processor, and screen. Alongside this model of an »internal telegraph,« what is most interesting is Winkler's »logistical reconstruction« (ibid., 283) of telegraphy with regard not only to its circuits, but also to the intersections involved: the »intermediate stations« at which officials sit to receive, decode, and forward messages. With the advancement of computers into telecommunication networks, manual work at these intersections is automated, that is, eliminated as a human activity: »Telegraphs were delivered by hand; only starting in 1935 are teleprinters equipped with a dial plate, thus adopting a technology that had gradually been introduced into the telephone network since 1908. With self-dialing service this link in the process chain is also transferred to the world of the machine. The provisional last step of this development […] is the computer. As soon as it enters into the intersections, the process chain is definitively closed; data and addresses are formatted in a unified manner, their handling and transfer are fully automated; the combinational circuits of the computer can transform the message and regulate the connection to addresses« (ibid., 289).

and punch cards, an existence that lies outside the time of transmission and yet is not very vivid. The transport goods that can be perceived at the operational end, the reproduced copy of an image conversion template, through all the intermediate steps aims at an iconically readable compression, which forms something from signals, from a time-sensitive and two-dimensionally distributed raster graphic stored in a logistically networked visibility depot—something that can be identified as an image, and not only by the police.

II.3 High Frequency Videos

Entering the archive, a viewing of a compressed video stream. »Film ID 3438« begins with two distinct title cards. First appears »Broad,« »Rolls 1A,« and »Claude Lanzmann SHOAH Collection« with a running timecode, then »Aleph Holocauste. BOB Video 53.«[446] The former is archival information that precedes the material and is thus ›external,‹ as it was added at a later point in time, apparently in the course of digitization. The latter is noted in handwriting on a clapperboard, which is used during film shoots to mark audio and video for editing in postproduction. This traditional optical signal, however, is itself framed within the image, as can be seen on closer inspection. A second camera (a different one, positioned subsequently) has filmed an image playing on a monitor, on which the clapperboard can be seen [figs. 7/8]. So this is not a direct image of a set, but the product of a further intermediary step in media translation. The two quoted texts are similarly stored paratextual elements of a streaming image that is currently being distributed, but they belong to different registers of imaging technology, in terms of both production history and media logistics. »Broad,« »Rolls 1A,« and »Claude Lanzmann SHOAH Collection« are archival articulations, while »Aleph Holocauste. BOB Video 53« points to the pragmatics of film production on a specific set. In this respect, even the first few seconds of this streaming video suggest that the archival material being distributed here is inscribed with a history of multiple incidents of media-technological formatting.

Taking the perspective of media historiography, this chapter begins by posing the general question of the extent to which streaming technologies have led to a digital restructuring of the Holocaust image archive. Recordings—of the historical context being evoked or of acts of witness to these events, recorded at a later time—which were always treated in the discourse of image theory as specifically ›marginal,‹ as paradigmatic test cases of the »limits of representation« (Saul Friedlander), are now subject to a distributability and operativity that is fundamentally modified by media technology. Recordings circulate differently, can be processed and mobilized in novel ways. In general, it should be noted here that digitization—whether as a transformation of mnemocultural communication or as transcoding of the archival holdings processed therein—has

446 Cf. »Interview with Pery Broad,« Film ID 3437–3443, Claude Lanzmann Shoah Collection, United States Holocaust Memorial Museum, https://collections.ushmm.org/search/catalog/irn1004810 (access date 08.08.2017).

only very recently become a discursive object in Holocaust Studies, but has for the most part come no further than questions about representation, the culture of commemoration, or the politics of memory. The great exception to this is a groundbreaking collection of conference proceedings,[447] whose contributions serve to historicize the influential conference organized by Saul Friedlander at UCLA in 1990,[448] while at the same time more profoundly confronting it with contemporary challenges. Alongside the post-colonial criticism articulated in comparative genocide studies,[449] the particular programmatic focus here is on the »›datafication‹ of the Holocaust«[450]: »[…] the representation of the Holocaust—prior to computational analyses and digital media—was a global moral yardstick in the era of linear media, particularly textual narratives, film, television, radio, and, to a certain extent, architecture. Each of these media forms is relatively sequential, additive, stable […] and control[s] reception and dissemination in predictable ways. […] This is hardly the case with interactive, web-based media (the Holocaust as video game or crowd-sourced models for tagging archival materials).«[451]

The following discussion takes up this diagnosis from the perspective of image and archive theory, but is also interested in analyzing concrete visual material that, like »Film ID 3438,« was until recently completely unknown. In many respects, an adequate examination of this material in terms of media historiography can only be achieved through close readings—although the question of the degree to which digitized visual Holocaust material can be addressed and processed as a ›big data‹ phenomenon also enters the picture: »[…] which comes from the fact that the Holocaust is one of the most thoroughly documented and studied events of the twentieth century […]. With new tools such as information visualization, mapping, text mining, modelling, and network analysis emerging from the digital humanities, the Holocaust may become the historical ›test case‹ for macroanalysis […].«[452]

447 Claudio Fogu, Wulf Kansteiner, Todd Presner (eds.), *Probing the Ethics of Holocaust Culture*, Cambridge, MA: Harvard University Press, 2016.

448 Saul Friedlander (ed.), *Probing the Limits of Representation: Nazism and the ›Final Solution,‹* Cambridge, MA: Harvard University Press, 1992.

449 Cf. Omer Bartov, »The Holocaust as Genocide: Experiential Uniqueness and Integrated History,« in: Claudio Fogu, Wulf Kansteiner, Todd Presner (eds.), *Probing the Ethics of Holocaust Culture*, Cambridge, MA: Harvard University Press, 2016, 319–331, and A. Dirk Moses, »Anxieties in Holocaust and Genocide Studies,« in: ibid., 332–354.

450 Claudio Fogu, Wulf Kansteiner, Todd Presner, »Remediations of the Archive,« in: ibid., 167–173.

451 Claudio Fogu, Wulf Kansteiner, Todd Presner, »Introduction: The Field of Holocaust Studies and the Emergence of Global Holocaust Culture,« in: ibid., 1–42, here: 33.

452 Ibid., 32.

Furthermore, the selected archival recordings are also instructive in the context of this study of the distributed image because they can be considered from the perspective of transmission history. The fact that they can be consulted today—in the form of digital MPEG-4 streams—is due to a transmission technology that, strictly speaking, distributed the visual material in the historical moment of its acquisition *before* it was stored. For this reason, continuing on from the phototelegraphic processes outlined in chapter II.2, another media technology will be considered here that precedes and is bound up with the digital distribution modes of the present. Through a detailed analysis of selected archival holdings from the Shoah Collection—focusing on those secretly filmed outtakes that document Claude Lanzmann's complicated encounters with Nazi perpetrators—›video‹ will be examined as an aggregate state of the distributed image that, alongside its televisual connections, in a certain sense also follows from the process of phototelegraphic communication. Concretely, this means: without the invention of analog video signal transmission, Lanzmann's outtake images would not be streamable today as digital data.

But first, back to the material, to »Film ID 3438.« The monitor that was filmed seems to be surrounded by a mat. This allows us to see not only the image area transmitted on the monitor, but also certain components of the apparatus receiving the transmission. Thus a monitor light glowing red is part of the archival image that the stream transmits, as is the conversational scene that is now unfolding, initially with no further points of reference [figs. 8/9/10]. A coffee klatch in a non-descript living room: a distinguished elderly gentleman sitting in an armchair, calmly smoking and conversing, a woman pouring the beverages, and two other voices, again a man and a woman, who speak from off screen, but are not visible (or not until later and then just briefly). The choice of framing, slightly from below and backlit by the light streaming in the window, appears suboptimal. Furthermore, the image is constantly permeated by interference signals of unknown origin—a series of prominent videographic artifacts, noise and disruption signals that, in combination with the unfavorable lighting conditions and the low resolution, result in the man, who is apparently the subject of this image, not being clearly recognizable: as if the camera were pointed at a phantom that was trying to avoid being registered. A precarious visibility is constituted here, which is deficient because it was not possible to create a more professional set. The entire context of acquiring this image had to be invisible in the moment of recording, had to remain a secret. Standing in the way of a better, higher-resolution picture of this man, this conversational constellation, were significant obstacles that had to be dealt with using media technology.

The audio, edited in from a separate source, is not free of disturbances either, but it records a conversation that is for the most part acoustically comprehensible, carried out almost exclusively between the two men. It begins, after a casual opening that refers to previous meetings, with an exchange about the mini-series HOLOCAUST, which, we learn, had recently been broadcast on television. This marks the date and location of this conversation, at least roughly: not long after the 26th of January, 1979, somewhere in Germany.

This information, however, also exists as the prepared metadata of the archival record, surrounding the stream, identifying and locating it as source material. The document, divided into a total of seven clips, is a part of the »Steven Spielberg Film and Video Archive,« which is run under the institutional authority of the United States Holocaust Memorial Museum (USHMM). The material is framed by a finding aid that connects the archival classifications as an interface: it reads »Story RG-60.5053, Film ID 3437–3443« under the title »Claude Lanzmann Shoah Collection: Interview with Pery Broad,« along with other specifications including »Event Date,« »Place,« »Copyright,« »Duration,« »Description,« »Contact,« and an annotation by which a digital facsimile can be called up: »Lanzmann's original transcript,« an extensive PDF with 153 pages of pictures of typewritten text.

The *SS-Rottenführer* Pery Broad, born in Brazil to a German mother, first served as a guard in the concentration and extermination camp Auschwitz-Birkenau starting in April 1942, then beginning in June 1942 in the notorious »*Politische Abteilung,*« which was closely involved with the operation of the gas chambers.[453] As a British prisoner of war he produced a written report,[454] which later also played a role when Broad appeared as one of twenty-two defendants in the first Frankfurt Auschwitz trial. In the court's justification for the lenient sentence—Broad was sentenced in August 1965 to four years in prison, but was already released in 1966 because of time served on remand—we read: »There is a strong suspicion that Broad beat people to death during interrogations, but there is a lack of conclusive evidence. […] It has been proven that Broad performed ramp duty [*Rampendienst*, separating the arriving prisoners into those fit for labor and those immediately sent to the gas chambers] […] Since it was not possible to determine how often Broad was active at the ramp, it is assumed to his advantage that he was there at least twice. Since this occurred at the time of the transports from Hungary, which in

453 Nikolaus Wachsmann, *KL. Die Geschichte der nationalsozialistischen Konzentrationslager*, Munich: Siedler, 2016, 819.

454 Cf. *Auschwitz in den Augen der SS. Rudolf Höß, Pery Broad, Johann Paul Kremer*, published by the Auschwitz-Birkenau Memorial and Museum, 2005.

general were fairly large, it is assumed that at least 1,000 persons were marked for death each time.«[455] Already at the trial hearing, Broad wanted nothing to do with his report, which, despite its high level of detail, managed to conceal his own person and his involvement behind a disconcerting, objectivistic narrative. The journalist Dietrich Strothmann commented on this in his trial coverage for *Die Zeit* in 1964: »Meticulously, like a film camera, he [Broad] even chronicled what happened during the shootings at the ›Black Wall,‹ during the gassings, during torture, in all their appalling detail. But the names of the guilty do not appear. […] Broad's report, this record of a man who was there, […] on the side of the henchmen, is nonetheless not a confession at all. […] It is the report of a tour guide through Auschwitz's chambers of horror. […]. An authentic eyewitness report, certainly. But it is also testimony of a lie. For nowhere in these fifty-six pages does Pery Broad speak of Pery Broad, the *SS-Rottenführer* and interrogation specialist, not with a single word. Remorse is alien to this man in his memories. Even before the court in Frankfurt he showed no sign of remorse, even for a moment.«[456]

When Lanzmann contacted him around fourteen years later, Broad maintained the Frankfurt strategy of public silence and denial. He did not want to appear as a witness in front of a camera, did not want to repeat his »clinical report« (Strothmann), did not want to add the missing first-person perspective to his third-person omniscient narrator, who apparently moved freely through the camp. Lanzmann changed his approach after this experience, adopting a fictional identity when contacting other SS men as well as expanding his media-technological equipment, which will soon be described in more detail. The fact that these new imaging operations were also used in a later meeting with Broad is documented by the films with the ID »3437–3443.« What is clear on these films is that Broad remains unmoved, he tries to leave himself out of it, reacts aversely to tape recorders (Lanzmann's reply: »It's just a question of memory. That's all«[457]). Nonetheless, Broad's »camera view,« the disinterested attitude of a »tour guide«—which Jonathan Little later sought to reproduce and exaggerate in literary form in *Les Bienveillantes* (2006)—was indeed captured clandestinely, recorded with camera technology, stored archivally. However, the visibility that was able to be created even without the consent of the perpetrators thanks to a new media technology—perpetrators who thus

455 Quoted in: Jerzy Rawicz, foreword to *Auschwitz in den Augen der SS*, 5–24, here: 20.

456 Dietrich Strothmann, »Das Protokoll des Perry Broad. Die verhinderte Beichte eines SS-Mannes aus Auschwitz,« *Die Zeit*, November 6, 1964.

457 Quoted from: »Interview with Pery Broad,« Film ID 3439, Claude Lanzmann Shoah Collection, United States Holocaust Memorial Museum, https://collections.ushmm.org/search/catalog/irn1004810.

believed that they were not surrounded by »media of jurisprudence,«[458] but in a neutral space of conversation free of technological recording and storage—was precarious, as the outtakes now show, marked by noise and disturbances. One could say, following Hito Steyerl, that this is why there is a »poor image« stored in the archive today, awaiting its »resurrection«: »It transforms quality into accessibility.«[459]

In order to do justice to this archival material, so effortlessly accessible and instantaneously streamable in today's digital space, we must first, at least roughly, reconstruct its complicated origin story. This story tells of a historical constellation that strategically boosted the exchange of »quality« for »accessibility,« on the level of media-technological planning as well. This speaks to the investigative and logistical energy that Claude Lanzmann and his team had to expend in order to be able, at the end of a day of shooting, to transfer a reasonably usable transcript into the working storage of film production, an energy that can be seen in another case in which the advertised conversation never came to be: »Film ID 3293«[460] begins with a sequence shot; color images, traveling shots recorded from a moving car, show an inconspicuous residential area accompanied by traffic sounds. A VW Golf from the 1970s is filmed through the rear window, which successfully performs a passing maneuver after twenty-four seconds. The street empties out, remains empty. When the camera position, bound to the car, comes to a stop, the visible timecode reads: »14:00:30:28.« The motor is turned off, the camera focuses on a three-story apartment building, no people can be seen. Then, for the first time, a voice is heard from off screen as Claude Lanzmann asks: »Voyons qu'est-ce que nous avons sur Laabs?«

Lanzmann quotes from an indictment from the Bonn public prosecutor's office from November 1963,[461] beginning to speak of »Gustav Laabs, chauffeur de camion à gaz pendant les deux périodes de l'extermination à Chelmno,« while on the visual level there is a continuous, gradual zoom, moving towards

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458 Cornelia Vismann, *Medien der Rechtsprechung*, Frankfurt am Main: S. Fischer, 2011.

459 Steyerl, »In Defense of the Poor Image.«

460 »Gustav Laabs and Lettre Becker,« Film ID 3293, Claude Lanzmann Shoah Collection, United States Holocaust Memorial Museum, https://collections.ushmm.org/search/catalog/irn1002784. Cf. Simon Rothöhler, »Streaming Outtakes. Medienphilologie des Täterbildes. Zur Webedition von Claude Lanzmanns SHOAH-Material,« in: Friedrich Balke, Rupert Garderer (eds.), *Medienphilologie. Konturen eines Paradigmas*, Göttingen: Wallstein, 2017, 307–331.

461 Cf. Mathias Beer, »Die Entwicklung der Gaswagen beim Mord an den Juden,« *Vierteljahrshefte für Zeitgeschichte* 35 (Juli 1987), 403–417.

a curtained window on the third floor of the apartment building [figs. 11/12]. The camera shifts to an observational mode, it obviously knows where it is and whom it is seeking. At this point the transcript notes: »Plan muet de l'immeuble avec femme à la fenêtre.«[462] In the seventh minute Lanzmann's monotonic, neutrally modulated reading of the historical court record ends with biographical information: »Il a été marié deux fois. Il a eu sept enfants de son premier mariage, dont deux sonts morts, et un enfant du second mariage. Il a un dentier et des troubles auditifs depuis 1934. Voilà.«

Following this we hear a sliding door opening on the soundtrack. After a cut a couple walks toward the building—just as in »Film ID 3437« it is Lanzmann, accompanied by his translator Corinne Coulmas. Another cut and we are now in the stairwell. It is dark, but the film team has brought lighting, the production apparatus is not camouflaged. A door closes, they ring at another. Gustav Laabs, whose name is written by the door [fig. 13], cannot or doesn't want to hear the signal, to open the door. But »Dr. Claude-Marie Sorel« does not give up so easily, he rings vigorously, even tries to turn the doorknob. After Lanzmann's experiences with SS men like Pery Broad and Franz Suchomel, he routinely used the fake identity of a postdoctoral historian (who was supposedly open to revisionist narratives) from the likewise fictitious »Centre d'études et de recherches sur l'histoire contemporaine« in Paris, during his efforts in the late 1970s to shed light on Nazi crimes using a list of names drawn up with the help of the State Justice Administration of Ludwigsburg, and after invariably tenacious negotiations by letter with German registry offices, to engage figures like the *SS-Hauptscharführer* Laabs in conversation, but above all: to bring them into the documentary image. Standing in the hallway of the apartment building, jiggling the bourgeois door of a post-war dentist presumably enjoying his twilight years, Lanzmann shows no sign of surprise. He knows that he is not expected—not by Laabs, not by the other Nazi perpetrators who were marked on the travel map of Germany for this epic film project, in cities like Ahrensburg, Mölln, or Altötting am Inn: »[…] I already knew, knew very early on, that I would not make this film unless the killers appeared in it.«[463]

Although the anticipated dialogue and the sought-after image never came to be, even a first glance at »Film ID 3293« shows it to be a multilayered document of its time. Not only in terms of the history of film—in the strict sense

462 Quoted from: »Laabs. Maison, LA4, 19,« in: https://collections.ushmm.org/film_finding aids/RG-60.5025_01_trs_fr.pdf.

463 Claude Lanzmann, *The Patagonian Hare: A Memoir*, London: Atlantic, 2012, XXX. For a foundational discussion of SHOAH, cf.: Stuart Liebman (ed.), *Shoah: Key Essays*, Oxford: Oxford University Press, 2007, and Jean-Michel Frodon (ed.), *Cinema & the Shoah: An Art Confronts the Tragedy of the Twentieth Century*, New York: SUNY Press, 2010.

of making-of footage that reveals Lanzmann's modus operandi during the roughly twelve years of shooting for *Shoah*—but also with regard to the incidentally recorded neighborhoods of the West German post-war milieu, which by its own admission is not interested in the things it could know but does not want to know. From the perspective of a descendent of the »society of perpetrators,«[464] another resident interviewed later in front of Laabs's apartment building, who had quickly shut his own door in the scene in the stairwell and railed against »French television,« all that there is to say about the gas van driver of Chelmno is: »I was interested in the neighbor, the person … and what we don't know doesn't interest me at all« [fig. 14].

The entire eleven minutes and twenty-nine seconds of »Film ID 3293« belong, as does »Film ID 3438,« to those estimated 250 hours of material that Lanzmann produced with camera operators like Dominique Chapuis, William Lubtchansky, and Caroline Champetier during years of research and shooting. The Laabs sequence, however, does not appear in the nine-hour condensed and edited version, the documentary film SHOAH, released in 1985. The footage is therefore outtakes,[465] unused material from shooting, leftover images whose status is initially defined by not being included in the finished context of interpretation and publication of a film, in not having been distributed through the channels of the institution of the cinema. In the case of the SHOAH project, however, a more cautious formulation is needed: the films are *still* outtakes, as

464 Cf. Frank Bajohr, »Täterforschung: Ertrag, Probleme und Perspektiven,« in: Bajohr, Andrea Löw (eds.), *Der Holocaust. Ergebnisse und neue Fragen der Forschung*, Frankfurt am Main: S. Fischer, 2015, 167–185, here: 168ff.

465 Vinzenz Hediger has suggested a perspective on the history of the »viewerless image« brought into play with the outtake question, not in the sense of a normative, art-historical optimization of the work, but in terms of information theory, as the »entropy of film«: »No matter how often a scene is shot, only one version finds its way into the rough cut and thus onto the screen. […] Every film thus only comes to be at the cost of making itself or other possible versions of itself superfluous several times over. The image that remains without the viewer for whom it was intended is the rule in the film industry—the exception is the image that is seen. […] One might imagine a quantitative film historiography that compiles an inventory of such shot ratios and, with mathematical precision, shows the factor by which the sum of visual material that has thus far been disposed of and destroyed in the history of film exceeds the sum of what has been shown […]. This would provide a gauge for the entropy of film or for the grand total of information that exists in the form of film. Conventional writing of film history that focuses on finished works, however, operates differently. Its object is the image that remains after excluding all the alternatives that are not incorporated (that is, without incorporating its information)« (Vinzenz Hediger, »Entropie des Films. Eine Geschichte des Kinos als Geschichte des Nicht-Sehens,« *Bildwelten des Wissens* 4.2 (2006), 9–20, here: 11f.).

Lanzmann created eight more films since 1999[466] using the material that was filmed into the early 1980s—his own archive, which he created due to a fundamental skepticism regarding existing archival images.[467]

Until just a few years ago, the portion of the material that was not aggregated into a ›film,‹ that is, it was not—at that time—published in the strict sense as a ›work,‹ had not been distributed by means of cinematic screen traffic, remained unseen—unless one took the path of an institutionally established archive consultation subject to official authorization.[468] This access to the unused footage of a documentary film project, which is actually quite unusual, only became possible starting in October 1996 because Lanzmann had decided that the SHOAH outtakes should no longer be seen as scraps or even an exclusive reservoir for future releases, but as a fundamentally accessible collection of historical documents, and consequently entrusted them to the cooperative ownership of two renowned institutions: the United States Holocaust Memorial

466 An essential feature of Lanzmann's cinematic works completed since 1999 is that they have successively expanded the historiographical scope of the first, longest, and most important film—SHOAH—to include narrating the history of Jewish resistance in Sobibór with the witness Yehuda Lerner (SOBIBÓR, 14 OCTOBRE 1943, 16 HEURES, 2001), or that of Maurice Rossell, a Swiss officer and delegate of the International Committee of the Red Cross who visited Theresienstadt and declared that he had inspected a »model camp« (UN VIVANT QUI PASSE, 1999). In 2010, Lanzmann released a conversation with the Polish resistance fighter Jan Karski, whose eyewitness account of the Warsaw Ghetto and the Belzec extermination camp had had disturbingly little effect on the Allies (LE RAPPORT KARSKI). After the 2013 film about the Viennese Rabbi Benjamin Murmelstein, who functioned as a so-called ›Jewish Elder,‹ also at Theresienstadt (LE DERNIER DES INJUSTES), yet another extract from the SHOAH project's material was released in the autumn of 2017—the four-and-a-half hour, four-part series LES QUATRE SOEURS, containing sequences with Paula Biren, Ruth Elias, Ada Lichtmann, and Hanna Marton that had not previously been released in edited, cinematic form.

467 As Brad Prager has maintained, a constitutive element of Lanzmann's recordings is that they relate to »missing images«: »Perpetrators are responsible for the overwhelming percentage of surviving images of German and Eastern European Jews taken from 1939 until the liberation of the camps, whether they were photographing for purposes of propaganda, out of historical interest, or as soldier's keepsakes. Following this argument's logic, one might say that there are few if any true photos and films of the Holocaust: the images are missing, because those we encounter are essentially part of a larger lie« (Brad Prager, *After the Fact: The Holocaust in the Twenty-First Century Documentary Film*, London: Bloomsbury, 2015, 8–9).

468 This was the method used for an essay by Susan Vice, who was able to view the analog 16mm holdings in the archive of the USHMM before the web collection was released. Her piece does not, however, deal with the material on Gustav Laabs and Pery Broad (cf. Susan Vice, »Representing the Einsatzgruppen: The Outtakes of Claude Lanzmann's SHOAH,« in: Nicholas Chare, Dominic Williams (eds.), *Representing Auschwitz: At the Margins of Testimony*, Basingstoke, UK: Palgrave Macmillan, 2013, 130–149).

Museum and Yad Vashem: The World Holocaust Remembrance Center. In 2012, the archival status and media format of this collection were again permanently changed when the USC Shoah Foundation provided funding for digitization and the material was gradually integrated into the web archive of the Steven Spielberg Film and Video Archive, also housed at the USHMM. By 2017, two hundred and twenty hours of film material encompassed in this collection had gradually been published there.[469]

Since the early 1990s—a phase that has been called the »era of the witness«[470] and is characterized by the founding of a variety of memory institutions such as the USHMM or the Visual History Archive of the Shoah Foundation[471]—the Film and Video Archive of the USHMM has specialized in collecting (audio)visual testimonies of the Holocaust: from amateur photographs from the ghettos of eastern Europe to the raw material for the so-called Atrocity Films that allied camera teams shot during the historical moment of liberating the concentration and extermination camps. The SHOAH Collection occupies a special position in this thoroughly unique archival context, if only because Lanzmann frequently made productive use of the extra material that was provisionally demarcated as outtakes with the world premiere of the film in October 1985, seeing it as source material to be read anew for further cinematic creations, which are not, however, new versions or revisions of the connections made in his previous works, but rather complement them. The auteuristic archival practice of continuously reconfiguring and updating, of redistributing the visibility stored by media technology as mediated through Lanzmann's authorial position, nevertheless maintains contact with the original film insofar as any approach to the SHOAH outtakes inevitably takes place against the backdrop of the sequences already compressed into cinematic form, that is, of that material which is shaped, edited, tied to media historiography, and is always absent from the USHMM web edition because it is already a part of official—and thus copyright-protected— SHOAH film history. The boundary within this edition therefore shifts in alignment with the publication history of images that, as soon as they become elements of a cinematic format that continues to write and discern the history of the extermination of European Jews, is contractually no longer able to be archived and addressed in

469 As of August 2017, the web collection consisted of eighty-one entries. Most contain digitized 16mm film material (formatted as MPEG-4 streaming videos), while some contain only audio files or information on the archived material.

470 Annette Wieviorka, *The Era of the Witness*, Ithaca, NY: Cornell University Press, 2006.

471 Andrew Hoskins views the establishment of witness video archives as the impetus behind the »second memory boom« (cf. Hoskins, »Introduction to Digital Memory and Media,« 15f.).

a documentary ›raw form.‹ If they are consolidated as film images, the archive withdraws them from the outtake streams.

As can be read in Lanzmann's autobiographical writing, the fact that, in this dynamically distributed movement of editing, scenes with Nazi perpetrators only appear peripherally or under specific media-technological conditions has little to do with the particularities of the mnemo-aesthetics and politics of memory that allowed SHOAH to be programmatically ›free of archival images‹ in its examination of the historical reality of German extermination machinery—that is, with those processes of realization and visualization that negotiate the much-discussed »limits of representation« with strategies of an »aesthetic transformation of the image of the unimaginable.«[472] Initially, the reason was simply a pragmatic issue of filming, a common material concern: the enormous difficulty of tracking down the relevant persons and then transporting them into adequate images of perpetrators.

Although recent research assumes there were 200,000 to 250,000 German and Austrian perpetrators directly involved in the Holocaust,[473] extremely few traces of them can be found in the historical film and television archives of the FRG (and the GDR).[474] This is generally the case, as Nikolaus Wachsmann has

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472 Gertrud Koch, *Die Einstellung ist die Einstellung. Visuelle Konstruktionen des Judentums*, Frankfurt am Main: Suhrkamp, 1992, 155. See also Gertrud Koch, Jamie Owen Daniel, Miriam Hansen, »The Aesthetic Transformation of the Image of the Unimaginable: Notes on Claude Lanzmann's ›SHOAH,‹« *October* 48 (1989), 15–24.

473 Bajohr, »Täterforschung,« 169.

474 Aside from the »images of perpetrators by the liberators« (cf. Ulrike Weckel, »(Ohn) mächtige Wut auf die Täter. Männliches und weibliches KZ-Personal vor den Kameras alliierter Befreier,« *Historische Anthropologie* 18/2 (2010), 232–246), especially those from the concentration camp Bergen-Belsen, where along with the *Kommandant* Josef Kramer around eighty SS guards were arrested and filmed, it is essentially a matter of the footage from the Nuremberg Trials (cf. Vismann, *Medien der Rechtsprechung*, 190ff.). Later court cases—with the exception of the Eichmann trial in Jerusalem (1961)—were barely documented on film at all. Another special case is Eberhard Fechner's DER PROZESS [THE TRIAL], which was made during the Düsseldorf Majdanek trials and contains scenes of conversations with the accused, such as the camp guard Hildegard Lächert (first broadcast on November 21, 1984). There are sporadic rarities such as Ebbo Demant's television documentary DREI DEUTSCHE MÖRDER. AUFZEICHNUNGEN ÜBER DIE BANALITÄT DES BÖSEN (1978), in which imprisoned members of the SS camp personnel (Josef Klehr, Oswald Kaduk, Josef Erber) are interviewed after the Auschwitz trials, as well as the BBC interview produced in 1979 with the deputy *Kommandant* of the Sobibor extermination camp, Gustav Wagner, who had been arrested the year before in São Paulo (GUSTAV WAGNER — ANGEL OF DEATH), and *KAMERAD KRÜGER* by Walter Heynowski and Gerhard Scheumann (about a »*Kameradschaftstreffen*« [»veterans' reunion«] of the *Waffen-SS* in Nesselwang in Bavaria, a GDR production from 1998; cf. Simon Rothöhler,

stated with regard to the source material in his overall assessment of the Nazi system of concentration camps: »In general those involved in the SS camps did not write any memoirs after the war, nor did they give interviews; they preferred to remain inconspicuous and to keep a low profile. Only the courts could compel them to break their silence.«[475] The group in question was not only able to evade appropriate judgments in court,[476] but in almost all cases also avoided being recorded and addressed in visual documents, which would have constituted a public viewing, an occasion for discussion, and potentially complicated their ability to continue their lives undisturbed: »According to its

»Vom Charakter einer Epoche. Zu den Filmen von Walter Heynowski & Gerhard Scheumann,« *Cargo Film/Medien/Kultur* 6 (2010), 53–54). Equally sporadically—and only if they wanted it themselves—individual Nazi perpetrators started turning up on German television history programs at the beginning of the 1990s (cf. Judith Keilbach, *Geschichtsbilder und Zeitzeugen — Zur Darstellung des Nationalsozialismus im bundesdeutschen Fernsehen*, Münster: LIT Verlag, 2008). The most recent (and presumably last) images of this group of people emerged again on the margins of court cases, beginning with the trial of the SS guard John Demjanjuk, who was sentenced by the Munich District Court in May 2011 to five years imprisonment for complicity in murder at the Sobibor extermination camp, which triggered a handful of other indictments against »*Greise*« [»geezers«] (Klaus Hillenbrandt, »Vier Greise auf der Anklagebank,« *taz*, Jan. 8, 2016, https://taz.de/Gerichtsprozesse-gegen-SS-Wachleute/!5263457/), such as the SS guard Reinhold Hanning.

475 Wachsmann, *KL. Die Geschichte der nationalsozialistischen Konzentrationslager*, 31. The outtakes of the SHOAH Collection, however, escaped Wachsmann's notice—especially Lanzmann's several hours of conversation with Pery Broad would have provided relevant source material on the system of Nazi concentration camps.

476 Indeed, between 1945 and 2005 criminal proceedings were carried out against 172,294 named defendants. However, this only led to trials against a total of 14,693 defendants, which resulted in 6,656 convictions, involving prison sentences over five years in merely 9% of all cases (cf. Andreas Eichmüller, *Keine Generalamnestie. Die Strafverfolgung von NS-Verbrechen in der frühen Bundesrepublik*, Munich: Oldenbourg Verlag, 2012; on the relationship between the two German states, cf. Annette Weinke, *Die Verfolgung von NS-Tätern im geteilten Deutschland*, Paderborn: Schöning, 2002). Few convictions, practically no images, but nonetheless valuable knowledge about the files emerged from these efforts, as Ulrich Herbert has noted: »Even if the number and severity of the convictions seems quite disproportionate in view of the crimes in question, what was begun here was indeed a historiographical experiment quite without precedent in the West German judiciary […]. The knowledge of German law enforcement agencies […] achieved a magnitude, density, and complexity over the course of the 1960s and 1970s, that historians—first in Germany, but then also in other countries—have only achieved since the 1990s« (Ulrich Herbert, »Holocaust-Forschung in Deutschland: Geschichte und Perspektiven einer schwierigen Disziplin,« in: Frank Bajohr, Andrea Löw (eds.), *Der Holocaust. Ergebnisse und neue Fragen der Forschung*, Frankfurt am Main: S. Fischer, 2015, 31–79, here: 43).

television image in the Federal Republic, the Holocaust was a crime without perpetrators, at least until the early 1990s.«[477]

Against this backdrop, the SHOAH outtakes that are now distributed in the form of streaming video are to be assessed from today's perspective. Considering the time of their creation—the end of the 1970s, when, for instance, no German publisher could be found for Raul Hilberg's foundational work on the annihilation of the European Jews[478]—it is clear that these are unique documents of a desire to counter the conjuring away of the perpetrators, widely-accepted in society and officially ensured in the West German legal consensus, with an interventionist pictorial politics that refuses to accept this silence and installs an extrajudicial framework of investigation and interrogation ultimately aimed at a different distribution of visibility: »There are six Nazis in SHOAH. Of those, three were filmed without their knowledge, the other three with a standard camera. But I filmed five others who do not appear in the film for reasons relating to the structure and composition of the film. What they had to say is in a safe place.«[479]

The film-pragmatic and media-technological implications of this plan to contest the perpetrators' sovereignty over their own image, their self-imposed invisibility—at the time of a consensually obstructed societal confrontation—can be drawn from Lanzmann's encounter with the *Obersturmführer* Karl Krestchmer, a member of the special commando 4a of *Einsatzgruppe* C, which was responsible for, among other things, the massacre at Babi Yar. The outtakes with the »ID 3247«[480] consist of two improvised attempts at conversation, in which »Dr. Sorel« manages to entice the reluctant Kretschmer to come out onto the front stairs, surrounded by flowers, and to get him involved in a

477 Wulf Kansteiner, *In Pursuit of German Memory: History, Television, and Politics After Auschwitz*, Athens, OH: Ohio University Press, 2006, 122.

478 Raul Hilberg's *The Destruction of the European Jews*—the declared reference text for the direction of Lanzmann's project, as evidenced by nearly five hours of conversation with Hilberg recorded in the winter of 1978/79 and now also included in the SHOAH Collection (cf. »Film ID 3768ff.,« in: https://collections.ushmm.org/search/catalog/irn1004662)—had already appeared in 1961. It was not until 1982 that the small publishing house Olle & Wolter procured the first translation (on the publication history cf. Götz Aly, »Angst vor der Wahrheit,« *Süddeutsche Zeitung*, October 17, 2017, and Raul Hilberg, *Anatomie des Holocaust. Essays und Erinnerungen*, Frankfurt am Main: S. Fischer, 2016).

479 Lanzmann, *The Patagonian Hare*, 592. These five other individuals are Karl Kretschmer (Film ID 3246–3247), Heinz Schubert (Film ID 3216–3219), and Pery Broad (Film ID 3437–3443), who will be discussed below; they are joined by Eduard Kryshak (Film ID 3357–3361) and Hans Gewecke (Film ID 3298–3313).

480 Cf. »Interview with Karl Kretschmer,« Film ID 3247, in: https://collections.ushmm.org/search/catalog/irn1004167.

dialogue that always seems on the verge of being broken off, but then does go on for quite some time (with a total length of nearly thirty minutes). In the second conversation contained in »Film ID 3247,« the camera position is concealed in the VW bus that always appears in SHOAH when the film switches over to an image of a perpetrator [fig. 15].

While the Laabs sequences were shot with a visible camera—with a complete film team, first in the car, then in the stairwell, finally in front of the apartment building—the Kretschmer outtakes are the product of a clandestine imaging operation. Kretschmer is filmed covertly, from the distance of the parked VW bus (on 16mm film material, in color); framed by zoom shots that are dependent on profilmic staging. Lanzmann first had to lure Kretschmer out of the hallway and then, using his own position on the stairs, into the open field of vision, the frame formed within the picture by plants on an arched trellis [figs. 16/17].

Framed in this way, Kretschmer appears affable, but he also remains on guard, initially claiming not to have much time, since he had some workers in the house who ostensibly required his constant instructions. While Lanzmann persistently confronts him with quotes from his own letters to family—which are archived thanks to the Ludwigsburg Central Office—he claims not to remember much about them or the actions of the special commando 4a. As reserved and fragmentary as Kretschmer's explicit statements might be, it is still the case that, in comparison with a written, transcribed testimonial text, the image of the perpetrator—as with every utterance recorded on film that can be viewed as testimony, independent of veracity, capacity of discernment, or willingness to provide information—produces a testimonial document that is differently layered and readable on various levels, if only because the situation in which the statement is made, the »sphere of the speech act,«[481] is also registered as visual information. Alongside the verbal pronouncements of the witness, his statement in a legally applicable sense, the filmed testimony also documentarily stores a view of the testifying subject as well as the act of attestation itself, that is, the historical moment of attesting. Discussing the testimonial status of Franz Suchomel's appearance—he belonged to the SS personnel of the »*Aktion Reinhardt*« in the Treblinka extermination camp and allowed himself to be provoked by Lanzmann into reenacting a cynical camp song, as can be seen in SHOAH —the literary scholar Shoshana Felman notes: »It is not a coincidence that as this testimony is unfolding it is hard for us as viewers of

481 Giorgio Agamben, *Remnants of Auschwitz: The Witness and the Archive*, New York: Zone Books, 1999; cf. also Simon Rothöhler, *Amateur der Weltgeschichte*, Berlin: Diaphanes, 2011, 141ff.

the film to see the witness, who is filmed secretly: […]; he agreed […] to give a testimony, but on the condition that *he* would not be seen as a witness: […]. In the blurry images of faces taken by a secret camera that has to shoot through a variety of walls and screens, the film makes us see concretely […] how the Holocaust was a historical assault on seeing and how, even today, the perpetrators are still by and large invisible […].«[482]

Within the framework of visibility that SHOAH has constructed for the perpetrators, when Lanzmann, with feigned casualness, asks about a remark in one of Kretschmer's letters about an aversion to blood sausage among members of the *Einsatzgruppe*, whose tastes obviously changed after their killing campaigns, Kretschmer lets slip—like an involuntary defensive reaction that apparently triggers reserves of bodily memory—that the ›global Jewish conspiracy‹ is still, as it always has been, at work behind the scenes of the American executive branch. Kretschmer then first speaks evasively about the preservation advantages of »canned sausages,« but then, after repeated questioning, remembers commando units who had seen enough blood upon their return from »excursions.«[483] When Lanzmann finally becomes a bit more confrontational, Kretschmer reacts with a hasty retreat into the safety of his hallway.

More indicative than his replies is the documented performance of ignorance and deflecting blame, which now, thanks to Lanzmann's clandestine film

482 Shoshana Felman, »In an Era of Testimony: Claude Lanzmann's SHOAH,« *Yale French Studies* 97 (2000), 103–150, here: 108.

483 Kretschmer's own letters, which Lanzmann quotes provocatively, are archived at the Yad Vashem remembrance center and are available online. The »blood sausage« question refers to this passage: »We spend the evenings either playing cards, drinking, or sitting around with the boss. I have to be with the boss a lot. When he wants to play cards, drink coffee, or drink schnapps, some officers have to be with him. You can't seclude yourself. I think I have made a good impression so far. The first few days, however, I was tired and quickly exhausted. But then I managed to make it through the nights and to be the last one to leave the field. I already told you about the shooting, which I was also not allowed to refuse. By and large they explained that they had now finally got a real man as managing director, whereas the previous one had been a coward. That's how people are judged here. Different than how we do it. But you can trust in your papa. He's always thinking of you and doesn't overshoot the mark. That's how our life is. We don't leave the building except to go to the cinema, theater, or when we're invited by agencies or officers. There's nothing going on in town. Sunday is exactly like any day of the week. But how nice it is back home with you. What's happening with my garden? […] It's nice that Mr. Kern is supposed to go to France. I think he would be too soft for the east. People change here though. You get used to seeing blood, but people don't really like blood sausage here. Greetings to you all« (Briefe des Obersturmführers Karl Kretschmer [Sonderkommando 4a der Einsatzgruppe C] an seine Familie, Sept./Oct. 1942, Yad Vashem, https://www.yadvashem.org/de/education/educational-materials/lesson-plans/architecture-of-auschwitz-birkenau/kretschmer-letters.html).

work, has made its way concretely into that »museum of gestures,«[484] which is distributed over the entirety of the SHOAH material just as are numerous »West German still lifes«[485]: meticulously tended rose gardens, living room wall units decorated with armies of knick-knacks, sofas protected from wear and tear by crocheted blankets, floral wall papers concealing traces of nicotine, old-fashioned curtains to obstruct views, all of which here form the grotesque backdrop for the often verbose defensive rummaging in pretended gaps in memory. From this perspective, the Kretschmer outtakes almost paradigmatically reveal the stubbornly defended post-war tranquility of a mass murderer who effectively has not been held accountable—a historical constellation that Lanzmann's cameraman Dominique Chapuis, who had to stay hidden in the VW bus, ultimately captures with a long sequence shot composed of zooms and pans, which, after a final radio communication by the SHOAH team that could almost be called cheerful (»pas mal«), finally comes to rest on the façade of Kretschmer's house. The task of guarding the rose garden falls not to the famous German garden gnome, but to the prominent sculpture of a soldier that decorates Kretschmer's well-tended home [figs. 18/19].

It is the same with the other outtakes. Even when the SS men, unaware that they are at that moment being made into images, refuse to make explicitly verbalized statements, touching on their historical role and guilt only in evasive movements, through the observation of everyday circumstances and gestural reactions Lanzmann's production of images achieves highly interesting testimonials that provide information in a condensed form about the living spaces, neighborhoods, and self-image of perpetrators directly involved in the Holocaust, who otherwise would, at best, only have left a trace in court records.[486] These visual documentary contents, including their ›surpluses,‹ which have grown over the course of historicization, thus fill a gap in the archive. Only since very recently have they been no longer just »securely stored« (Lanzmann), but also accessible: by way of video codecs, which make the material transportable according to algorithmic calculations.

484 Cf. Ferro, »Gibt es eine filmische Sicht der Geschichte?«

485 On this, cf. also the photographic inventory in Christian Werner, *Stillleben BRD*, Bielefeld: Kerber, 2016, and Philipp Felsch, Frank Witzel, *BRD Noir*, Berlin: Matthes & Seitz, 2016.

486 From a film history perspective, the outtakes also provide value with regard to the philology of editing. Lanzmann's authorial decisions, the aesthetic and historiographic settings, are revealed in great detail against the backdrop of the unused material. It is thus possible to reconstruct the background of the complete material acquired on film—the »total amount of cinematic information« (Hediger) of the SHOAH project—from which the selection of certain passages was made, what inclusions/exclusions were concretely operationalized in the editing of SHOAH (cf. Rothöhler, »Streaming Outtakes«).

II.3.1 Video Signal Histories

The audiovisual archival material of the USHMM circulates according to the format rules of a standard that largely dominates the global transfer of digital moving images: MPEG-4. The videographic work of compression and decompression is carried out by »Advanced Video Coding« (AVC), which is specified in MPEG-4 Part 10 and is called H.264. The task of this codec—like its forerunner and successor, which are closely intertwined with it[487]—is defined in terms of media logistics. It foregrounds the optimization or »economization« (Sterne)[488] of digital signal processing (DSP): »[…] the standard in fact defines a ›transport‹ system rather than just a codec.«[489]

This transport system also includes the container format MP4, which is defined in MPEG-4 Part 14. While codecs are pairs of algorithms that encode and decode digital data streams, allowing them to become transmittable, encryptable, and compressible, the container formats, which must be distinguished from codecs, merely describe how the packet bundles the various traces of data. In multimedia containers, video, audio, subtitle, and metadata traces are tied together in such a way that they can be played with temporal consistency based on synchronizing information. Because digital data cannot be stacked ›on top of each other,‹ but only stored sequentially, the individual traces must also be dismantled into small parts or »interleaved.« In this context, an open format such as the open-source development Matroska can be considered an all-purpose container, because MKV supports a variety of codecs (and even facilitates embedding foreign container formats). Clearly less flexible in this regard is the MP4 format, which emerged from Apple's Quicktime and as a container for web streaming competes, for instance, with Google's WebM, a format that was optimized for the HTML5 standard and operates with the video codecs VP8 and VP9. For web streaming in general, it is important that the fragmented, dismantled products of the interleaved data traces each contain a time stamp to keep sound and image synchronous in accordance with the transport plan, even in the case of transmission delays and disturbances. The term ›container,‹ known from the logistics of globalized world trade, seems to have been appropriately chosen here, as can be read in Mark Levinson's history of the standardized holder of transport goods: »It has

487 The current successor H.265 (MPEG-H Part 2) runs under the acronym HEVC (High Efficiency Video Coding).

488 Cf. Chapter I.2.

489 Adrian Mackenzie, »Codecs. Encoding/Decoding Images and Sounds,« http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.324.1153.

no engine, no wheels, no sails: it does not fascinate those captivated by ships and trains and planes, or by sailors and pilots.« But: »The value of this utilitarian object lies not in what it is, but in how it is used. The container is at the core of a highly automated system for moving goods from anywhere, to anywhere, with a minimum of cost and complication on the way.«[490] The same applies to visual data traffic. Here the container formats serve to preserve and transfer information that is organized within the file such that it maintains a packet structure which, on the outside, is simplified, stable, compatible with multiple platforms, and consequently optimized for transport.

The actual reduction of multimedia data packaged in this way, which serves equally to conserve both storage and transfer capacities, occurs by way of a complex calculation of the redundancies contained in the data, which can be left undistributed for the sake of optimized bit rates. The codecs held within the containers are made up of algorithms that standardize transport modalities with the goal of increased shipping volumes and accelerated shipping times. It is thus generally expected that the volume of video data in need of distribution will increase. The identification of selected redundant components occurs against the backdrop of a long history of »perceptual engineering«: a specific perceptual knowledge is thus always also encoded, which, in relation to audiovisual data processing, indicates a genealogy that extends far into the past.[491]

»Codecs mean more pictures, more often, in more places«[492]—this is how Adrian Mackenzie succinctly describes the driving vector of this economization. Nevertheless, the technical details are not uncomplicated. For one thing, current compression procedures reduce those luminosity and chrominance values that are estimated to be barely or not at all perceptible within a certain frame—whereby the human eye fundamentally perceives colors with less

490 Levinson, *The Box*, 15 and 1–2.

491 Jonathan Sterne and Dylan Mulvin have shown that the television norm NTSC, for instance, also plays a decisive role in considering the visual culture of the 20th and 21st centuries from the perspective of compression history: »As a protocol built around compression, analog color television was a major modality of visual culture in its own right for decades. But it also did much to set the terms on which the material form of today's fleet of online images and image standards would be composed and the presuppositions around the nature of looking that would be built into them (alongside other media that had to negotiate issues of compression, like telephony and radio, and in different registers, photography and cinema). […] Color TV's politics of infrastructural and visual limits anticipated the material condition of online images today« (Jonathan Sterne, Dylan Mulvin, »The Low Acuity for Blue: Perceptual Technics and American Color Television,« *Journal of Visual Culture* 13/2 (2014), 118–138, here: 131–132).

492 Mackenzie, »Codecs. Encoding/Decoding.«

differentiation or resolution than it does brightness values, so there is generally greater potential for economization with chroma subsampling. Alongside these spatial redundancies—which calculate the relations of proximity between pixel blocks for the purpose of potential margins for leveling, that is, lossily—MPEG primarily addresses temporal references. In the final analysis, the goal is always the same: to identify data that need not be transferred multiple times, while maintaining a relatively constant picture quality. In other words, it is about image components that either do not change within a temporal sequence, or change so minimally that it is not noticeable if they are only transferred once. The greater the similarity of the pixels within a frame, and the less the mobility of the pixels between frames, the more efficient it is from the point of view of transfer costs. Because of the tendency to replace static imagery with streaming, the visual culture of the present is dominated by codecs such as MPEG, whose algorithm pairs calculate moving bitmap patterns in the interest of their compressibility.

The inter-frame level that is central here targets moving image components, those data shifts that ensue between two frames (or precisely ought not ensue). Instead of transferring a series of complete images, quasi-cinematically, or being restricted to compressing static image components with little differentiation (such as monochrome backgrounds), MPEG distinguishes at this point between keyframes, which identify and initiate or determine a sequence, and b-frames, which merely contain difference values and are occasionally called »inbetweeners,« a term taken from classical keyframe animation (this was the term used by Disney and Co.). The fundamental unit of this processing operation consists of 16x16 pixels called a macroblock—an elementary processing unit that segments a frame (sometimes also in subunits of 8x8 pixels, the blocks) without having to begin at the level of the individual pixel. Macroblocks are calculated using algorithms that describe the moving data as motion vectors:

> Interpicture compression relies on forward and backwards correlations, and in particular on the calculation of motion vectors for blocks. In the process of encoding a video sequence, the codec analyzes for each picture how blocks have moved, and only transmits lists of motion vectors describing the movement of blocks in relation to a reference picture. This fundamentally alters the framing of images. We have already seen that rather than the raw pixel being the elementary material of the image, the block becomes the elementary component. Here the picture itself is no longer the elementary component of the sequence, but an object to be analysed in terms of sets of motion vectors describing relative movements

> of blocks and then discarded. The ›picture‹ after encoding is nothing but a series of vectors describing what happens to blocks. Decoding the MPEG stream means turning these vectors back into arrangements of blocks moving between frames.[493]

Within a video stream, MPEG thus establishes a hierarchy of visual data units saturated with information in different ways: from autonomous reference images (keyframes, or actually: i-frames), which are intracoded, that is, completely coded, because they function without any relation to the other frames, to intermediate or supporting images that, in the case of b-frames, which are defined by their differences from previous and subsequent individual images,[494] generally contain only one ninth of the data of an i-frame, but which are bidirectionally dependent on them. These complex correlative and predictive modifications—consisting of redundancy reduction that is both spatial (discrete cosine transformation) and temporal (block-based predictions of movement)—are what allow video data to be capable of being streamed in the first place, reaching deep into the visual materiality and texture of digitally distributed moving images, constitutively calculating the perceptual capacities directed at them in the relation to capacities for transmission: »The result is an increasing equivalence of each image with every succeeding image.«[495] Codecs process visual (and audio) data from the perspective of an economy of the transmission channels that exist in relationships of consumption, standardizing negotiation processes between infrastructural circumstances, the conditions of the channels, and cultural codings, which include not least the conventions of how images appear: »Transform compression and motion estimation profoundly alter the materiality of images, all the while preserving much of their familiar cinematic or televisual appearance.«[496]

The infrastructural dimension of the transport system, like the operativity of the codec, can only be empirically perceived comparatively directly when the transmission process enters into the image as an artifact of compression (motion blocking, mosquito noise, and quilting are the most familiar forms).

493 Ibid.

494 In contrast to the so-called p-frames, which only relate to individual previous images and thus are not bidirectional.

495 Sean Cubitt, »The Latent Image,« *International Journal of the Image* 1/2 (2011), 27—37, here: 34. For Cubitt's ultimately rather aesthetic and data-economic critique of predictive operations of motion compensation, see also Cubitt, »Codecs and Capability,« in: Geert Lovink, Sabine Niederer (eds.), *Video Vortex Reader: Responses to YouTube*, Amsterdam: INC, 2008, 45–51, and Cubitt, *Practice of Light*, 246ff.

496 Mackenzie, »Codecs,« 54.

Materialized as noise,[497] glitch (art),[498] or buffers,[499] the disturbances, delays, and interruptions highlight the fact that the codified economization of digital signal processing is based on time-sensitive calculations of fragmenting and recombining images. Framing the matter epistemologically as »aesthetic of lag«[500] or »failure studies,«[501] media studies has recently taken a variety of approaches to reflexively exposing inefficiencies and disturbances, against the widespread notion of ubiquitous and uninterrupted data flows.

This brings us back to the focus of this chapter, the archival streams of the SHOAH Collection—which can now be transported to the network-infrastructural and codec-technological conditions of economically calculated data transfer outlined above—insofar as these films also contain markers of disturbance that point to transmission processes and their requirements. From the perspective of media historiography, the technical production of visual material that can be read today as a historical source intersects with a history of the video signal in which digital and analog operations intertwine in multiple respects. To begin with, this is simply because the video streams, like the historical crime scene photographs of the NYC Department of Records, are digital reproductions, which in the present case were created on the basis of 16mm film material. Behind digital artifacts, which can result from retro-conversion as well as from the connective quality that is inscribed through adaptive transmission, additional visual disturbances can be visualized here that belong to the original data, and thus have nothing to do with the codec.

If, for example, we look more carefully at the beginning of the material on Pery Broad (»Film ID 3438«), the first thing we notice is the leader, which is attached before the actual images on cinematographic demo reels and typically contains technical information about the reel such as act and print number or other information on the aspect ratio and sound system [fig. 20]. The leader digitized for the streaming archive documents that the MPEG data must have gone through a phase of existence as film material. But when immediately after the leader there appears no profilmic scene, but instead a monitor crisscrossed

497 For a perspective from media archaeology, cf. Mara Mills, »Deafening: Noise and the Engineering of Communication in the Telephone System,« *Grey Room* 43/7 (2011), 118–143.

498 Cf. Krapp, *Noise Channels*.

499 Cf. Neta Alexander, »Rage against the Machine: Buffering, Noise and the Perpetual Anxiety in the Age of Connected Viewing,« *Cinema Journal* 56/2 (2017), 1–24.

500 Nicole Starosielski, »Fixed Flow: Undersea Network as Media Infrastructure,« in: Starosielski, Lisa Parks (eds.), *Signal Traffic: Critical Studies of Media Infrastructures*, Champaign: University of Illinois Press, 2015, 53–70.

501 Alexander, »Rage against the Machine,« 23.

with video disturbance signals [fig. 8], it becomes clear that while the primary system of image acquisition was analog, it did not operate by means of a film camera, but using a system of video signal transfer. To anticipate the point: the digital SHOAH archival stream video that plays MPEGs today via a computer network connection is based on retro-digitized film material, which for its part merely functions as the storage medium for another analog recording and transmission, formatted through video technology. The digital streaming video image was thus already a video image, even before the act of storage and digitization: as a direct product of an analog transmission technology.

The reason for this, as suggested above, has to do with the specific problematic of the image of the perpetrator. Because SS members such as Pery Broad did not wish to be recorded, to be distributable in visual form, the SHOAH production developed a technologically sophisticated stratagem of transmission. Exactly how this worked can be reconstructed from an encounter with another perpetrator. In 1979 Lanzmann, accompanied by Coulmas, rang at the door of the dignified Ahrensburg villa of Heinz Hermann Schubert, as can be gathered from »Film ID 3216.«[502] Schubert was the deputy officer at the side of Otto Ohlendorf, commander of *Einsatzgruppe* D. Schubert's significance for the systematic mass shootings that took place in the occupied Soviet Union—which Timothy Snyder still described as the »ignored reality« of Holocaust historiography as late as 2009[503]—far exceeded his rank, which at first glance might seem relatively low. He belonged de facto to the small leadership team of *Einsatzgruppe* D, which was responsible for the murder of around 90,000 people. In the so-called Einsatzgruppen Trial against twenty-four SS commanders, the ninth of a total of twelve Subsequent Nuremberg Trials, Schubert was also condemned to death—in part due to his direct involvement in the massacre of Simferopol (»Christmas massacre,« December 1941)—but was reprieved to a prison sentence in 1951 by High Commissioner John McCloy. This political concession, made by the Advisory Board on Clemency for War Criminals in the context of integrating the FRG with the West, allowed for a mass murderer like Schubert to be released as early as 1952, after the remaining period of incarceration of six years—already incomprehensibly short—was remitted for »good behavior.«

Like the Broad material, the first outtake images from Lanzmann's encounter with Schubert—material with a total running time of almost 100 minutes,

502 Cf. »Interview with Heinz Schubert,« Film ID 3216–3219, Claude Lanzmann SHOAH Collection, USHMM, https://collections.ushmm.org/search/catalog/irn1004055.

503 Timothy Snyder, »Holocaust: The Ignored Reality,« *New York Review of Books*, July 16, 2009, 14–16.

which begin peacefully and end tumultuously in the front yard—show a video monitor that has been filmed in completely darkened surroundings. Under a thick layer of videographic interference signals the screen shows a hazy image of Lanzmann ringing the doorbell. A domestic worker opens the door, Lanzmann candidly announces that he wants to speak with Herr Schubert and astonishingly, without either introducing himself or his reason for coming, is then asked into the entryway by Schubert's wife, who has rushed to the door. The scene is filmed shakily from below, the camera position moves, with an odd lack of guidance, following the hostess and »Dr. Sorel« in the direction of the living room.

Here as well the relatively low-resolution black-and-white image remains unstable and prone to interference, apparently always on the verge of veering definitively into a pure texture of videographic artifacts [figs. 21/22/23/24]. It is clear, however, that they have nothing to do with the typical interference patterns associated with video as a storage medium, with a data carrier produced from a magnetized plastic sheet and the corresponding degenerative effects.[504] The framing is also striking. The perspectives shift, come across as arbitrary, are in any case not positioned freely and deliberately as framing or as the staged solution to a pre-arranged conversational configuration. The audio, on the other hand, is relatively clear, discernably close to Lanzmann's position in space. From the sound of rustling fabric, we can presume that the microphone is hidden under his clothing. Equipped with this media technology and waiting with the hostess for Heinz Schubert, who is allegedly busy with yard work, Lanzmann and Coulmas sit on a sofa exchanging trivialities—mustering up somewhat reserved bourgeois manners on account of the unexpected visit—about holiday destinations in South Tyrol, notoriously popular in former-Nazi circles. In the quest for innocuous small talk, some of the side comments even broach the topic of the (second) oil crisis of 1979, but this only contributes to making the reason for the visit all too obvious as an anathema coated with silence. Frau Schubert seems to know perfectly well what this visit is about (even if, as it turns out, there was an initial confusion). The exceedingly polite »Dr. Sorel,« who makes a jovial remark about the Schuberts' lavish garden, had already written a letter to the SS man some time previously, but, as everyone in the room is aware, he did not receive an answer, for good reason, much less an invitation.

504 A detailed typology of such visual disturbances is offered by an elaborately produced reference work, which is first and foremost concerned with analog art videos: Johannes Gfeller, Agathe Jarczyk, Joanna Phillips (eds.), *Kompendium der Bildstörungen beim analogen Video*, Zurich: Scheidegger & Spiess, 2013. Cf. also Lucas Hilderbrand, *Inherent Vice: Bootleg Histories of Videotape and Copyright*, Durham, NC: Duke University Press, 2009.

In front of the property on this summer afternoon the VW bus is parked once again, which has meanwhile been converted into a kind of mobile television studio [fig. 25]. Inside this central vehicle of the SHOAH project is Dominique Chapuis, but not the crucial camera for this day of shooting. As was the case with Karl Kretschmer, the filming was done in secret. However, this recording did not bring the SS man into the documentary image through a discrete zoom maneuver, but using an image transmission model. The SHOAH team was operationally connected, as they had been in the Broad visit, by an invention of the Grenoble engineer Jean-Pierre Beauviala, who was known in part for his collaborations with Jean Rouch and Jean-Luc Godard. At this point in time the invention was in Coulmas's handbag, as Claude Lanzmann recollects in his autobiography:

> The ›Paluche‹ was a cylindrical camera about thirty centimeters long and not very wide that could be pointed by hand (hence the name, meaning ›paw‹) without needing to look through a viewfinder. It worked using a high-frequency video system; there was no film or tape inside, instead it transmitted a signal that could be received within a limited radius—by a VCR that recorded and stored the footage. [...] We bought an ordinary linen bag, the sort any woman might carry, and decorated both sides with little stars and circles of silver paper. [...]. The Paluche lay at the bottom of the bag in a foam cradle, and where the lens was, we cut a circular hole in the linen and replaced it with a disc of a silver paper that allows light to pass through. Once the Paluche, the transmitter and the antenna were in place, we filled the bag with a variety of items—newspapers, books—that were all readily visible.[505]

The legendary Paluche, later theorized by Raymond Bellour as an »extension of the hand«[506] in an essay about Thierry Kuntzel, transformed the visibility distribution of the SHOAH project: »[...] the most unexpected images become possible, challenging the supremacy of the look in the organization of the visible.«[507]

Jean-Michel Frodon has linked Beauviala's camera innovations to the socio-politically altered ways of circulating visual signals that are usually coded with

505 Lanzmann, *The Patagonian Hare*, 573, 580; cf. also Vice, »Representing the Einsatzgruppen,« 132f.

506 Raymond Bellour, »Thierry Kuntzel and the Return of Writing,« *Camera Obscura* 4 (1983), 28–59.

507 Ann-Marie Duguet, *Vidéo, la memoire au poing*, Paris: Hachette, 1981, 166 (quoted in: Bellour, »Thierry Kuntzel,« 57).

the abbreviation »May 1968,« denoting the dawn of a new age.[508] Like other inventions by Beauviala's company Aaton, for instance the cineminima (a light 16mm guerilla camera that could be short-circuited with a suitcase projector running on a car battery[509]), which was used by the militant leftist film activist J.P. Carson for the Black Panther movement, the Paluche also belongs to a politically motivated project that interprets the technological flexibility of the camera's position and the »unexpected images« that this enables as an opportunity to intervene in fields of powerful social conflict, whose relative opacity is meant to be challenged by creating alternative public spheres. This was also part of the visibility politics of the SHOAH project, in that Lanzmann was unwilling to grant the Nazi perpetrators, who were enjoying their retirement years in physical freedom, the ability to decide for themselves who would question them in what way about their historical role and responsibility, where they would be visible, what public discourses their images would circulate in and how they would be framed, and finally how that image would then enter the archive. The fact that, on the one hand, Beauviala's project of reconfiguring the meeting of technology, aesthetics, and politics—a project conceived as emancipatory from the very beginning—is historical,[510] while on the other hand the history of the apparatus's use extends into the present, is evident not least in the fact that the Paluche has experienced a kind of retro-renaissance as a video art camera in recent years[511] and can certainly be regarded as the forerunner of the newer micro-camera systems.

508 Cf. Jean-Michel Frodon, *Le Cinéma Français de la Nouvelle Vague à nos jours*, Paris: Flammarion, 1995, 323ff.

509 On the history of portable projection technology, cf. Haidee Wasson, »Protocols of Portability,« *Film History* 25/1–2 (2013), 236–247, and Wasson, »Suitcase Cinema,« *Cinema Journal* 51/2 (Winter 2012), 150–154.

510 In a dispute moderated by Alain Bergala between Godard and Beauviala about the developments of the Aaton 35–8, the tension surrounding the issue can be traced in great detail as a collision of aesthetic, political, and commercial demands (Jean-Pierre Beauviala, Jean-Luc Godard, »Genesis of a Camera,« *Camera Obscura* 5/13–14 (1985), 163–193).

511 This second career—in which the specific videographic materiality of images from the Paluche probably became novel and attractive once again as an aesthetic difference in part because they position a form of perception marked by transfer protocols against the dominant digital visualities—begins quite early with works by Nam June Paik and Thierry Kuntzel up to Philippe Grandrieux. In relation to the SHOAH material, it has the consequence that the outtakes, which are significant even beyond documentary history, on detours through the aesthetics of representation are also sometimes reminiscent of current discussions of the white cube. On video aesthetics in general in the art context, cf. Yvonne Spielmann, *Video. Das reflexive Medium*, Frankfurt am Main: Suhrkamp, 2005, 230–372.

It was in any case significant for the Schubert and Broad operations[512] that not having a viewfinder and storage function implied an immediate necessity to transmit the recorded visual signal. In Maurizio Lazzarato's words: »All the work of video occurs between this input and output: connect to a flow, work it, transform it, and return it to circulation to be worked again.«[513] With the Paluche, seeing and broadcasting coincide to a certain degree in the form of a stream. The processing of the acquired video data did not need to be calculated with a time for development since the playback directly followed the transmission. Essentially, the SHOAH team had begun to install a video-specific closed-circuit system: »Video—in contrast to developing celluloid with film—allows for the immediate monitoring of what is being recorded. With video, a cybernetically media-epistemological thing, immediate feedback, enters television technology—a temporal process that disappears in the time frame of the selective present.«[514] Wolfgang Ernst fundamentally understands video in terms of television technology. The transmission, the »pure act of processing the visual signal«[515]—not the electronic storage option of video recorders and magnetic tape, which had superseded the previous practice of recording television signals using shellac records, the only possibility at the time—is thus paramount. From the perspective of the media archaeology of »electronic images from a distance« (Franz Pichler), which begins with the time-sensitive mechanical-optical processes of early phototelegraphy, electronic television—beginning with Philo Farnworth's image dissector tube and Vladimir Zworyin's iconoscope[516]—in principle accelerates those mechanical operations of fragmenting images that were already aiming towards distribution without storage as early as 1884, with Paul Nipkow's patent registration for the electric telescope.[517]

512 The Paluche was used for a total of six persons. In addition to the cases of Broad and Schubert discussed extensively here, it was also used with Eduard Kryshak, Hans Gewecke, Heinz Schalling, and Franz Suchomel (the last two appearing in SHOAH).

513 Maurizio Lazzarato, *Videophilosophy: The Perception of Time in Post-Fordism*, New York: Columbia University Press, 2019.

514 Wolfgang Ernst, »Video und Videozität. Zur Archäologie einer medialen Konstellation,« in: Harro Segeberg (ed.), *Film im Zeitalter »Neuer Medien« I: Fernsehen und Video*, Paderborn: Fink, 2011, 43–69, here: 49.

515 Ibid., 55.

516 Pichler, *Elektrische Bilder aus der Ferne*, 70ff.

517 Johannes Gfeller recognizes the »temporal primacy of transmission before storage [as] virtually the norm: The camera obscura, but also its inverse, the *laterna magica*, existed long before light-sensitive material. Animated images—in projection as well—existed before celluloid strips and before the possibility of recording ›according to nature.‹ Sound transmission precedes sound storage, and this in a technology-historical reversal:

The analog transmission of discrete visual elements—which uses a line skip operation to write fifty fields per second that are constantly telescoped into one another in order to generate the stable perceptual impression of a relatively flicker-free television image—is connected with the digital datagram series that operationalizes a codec like MPEG's H.264 through the fundamentally open processuality and the principle of fragmentation. The history of the technologically distributed image is based on fragmentation and redistribution that occurs within the image. From phototelegraphy and television and video technology to today's visual data streams, distribution has always presupposed discretization. Images are transferred as pixels: rasterized, written in lines, laminated into macroblocks. In terms of the technology of signals, the electronic flow of images, the electronic beam that sweeps in microtemporal intervals[518] can already be conceived as streaming, as Ernst puts it: »The term streaming video, however, is already a placating metaphor for broadband transfer in the internet; in contrast to the video flow of waves, what governs here is logical, discrete time.«[519] Yvonne Spielmann similarly locates the analog video image within a process of exchange—which she somewhat one-sidedly interprets as a media-specific figure of reflexivity—with the »numerical visualizations« that are processed by digital video codecs.[520]

For the analog transmission process, the image signals of the Paluche used high frequencies. The interference signals in the archival material that are clearly visible today result from transmission problems that generally increase in the case of wireless radio transmission at frequencies above 100 MHz. At these frequencies no visual connection is necessary (as is the case, for instance, with infrared or microwave links). However, low range, reflections from buildings, etc., are quickly translated into signal distortions and faulty connections.

transmission already occurs electrically, while the storage that was invented later still functions mechanically for another five decades« (Johannes Gfeller, »Videotechnische Grundlagen,« in: Gfeller, Agathe Jarczyk, Joanna Phillips (eds.), *Kompendium der Bildstörungen beim analogen Video*, Zurich: Scheidegger & Spiess, 2013, 116–125, here: 116).

518 Cf. Axel Volmar, »Die Mikrotemporalität der Medien. Manipulationen medialer Zeitlichkeit in der Geschichte von Film und Video,« in: Ingo Köster, Kai Schubert (eds.), *Medien in Raum und Zeit. Maßverhältnisse des Medialen*, Bielefeld: Transcript, 2009, 117–142.

519 Ernst, »Video und Videozität,« 49.

520 »The correspondence of a transformation image in the electronic and the digital medium ends at the category of optionality, for an electronic representation cannot simulate/dissimulate as a digital representation created by digital programming commands can« (Spielmann, *Video*, 88).

Lanzmann recalls the resulting problems and the strategies used to combat them:

> If there was a television transmitter nearby, or if there were too many powerful electrical devices in the apartment itself, the footage was blurred and unusable. In addition, it was essential that the Paluche be directly in line with the minivan. If the minivan was parked on one side of the building, and I was forced to interview on the other, the footage was not received. Sometimes I would arrive in a house or an apartment entirely unknown to me, only to be brought into a living room at the back of the building while the minivan was parked in the street by the kitchen—in such cases, I had to work out the layout of the apartment and come up with an idea on the spot, taking my interviewee firmly by the arm and leading him, for instance, into the kitchen, as though I had decided on a quick, informal conversation, wanting to avoid disturbing anyone.[521]

In Heinz Hermann Schubert's living room, through the side of Coulmas's handbag the cathode ray recorded light information, which was translated into video signals, modulated for stabilization, and transferred via analog waves continuously and steplessly to the phosphor layer of a monitor inside the VW minivan, where Dominique Chapuis constantly tried to adjust the receiver antenna as the disturbance persisted [fig. 25].[522] For the final moment of this historic transmission, however, there is no Paluche image in the SHOAH collection, but merely a disturbance tracker in the form of a facsimiled remark in the film transcript: »04:19:00: Discovered! (No pic)« [fig. 26].[523]

Because it had become too hot for Chapuis in the parked VW minivan, he had rolled down the side window a bit, so a neighbor walking by was able to

521 Lanzmann, *The Patagonian Hare*.

522 Cf. »Interview with Pery Broad,« Film ID 3441, Claude Lanzmann SHOAH Collection, Interview with Pery Broad, United States Holocaust Memorial Museum, https://collections.ushmm.org/search/catalog/irn1004810.

523 Quoted in: https://collections.ushmm.org/film_findingaids/RG-60.5013_01_trs_de.pdf. There is also a sound recording of the final minutes of the encounter with Schubert, which at the time of writing (2017) had not yet been transferred into the web archive. For almost all the SHOAH outtakes, however, digital copies of the film transcripts created for editing during production have been made available. Alongside transcriptions of the dialogues, these transcripts also contain handwritten remarks about staging arrangements (such as the presence of persons and the radius of their action), marks underlining important passages in the conversations, as well as—primarily in the case of the experimental Paluche operations—specifications on the unstable relations between sound and image referenced with time codes.

hear Heinz Schubert's electronically distorted voice like a live radio broadcast coming from the minivan and, in another case of something more than just neighborly solidarity, sounded the alarm by telephone. Distressed, the Schuberts then called for their sons, who were apparently easily agitated, and the situation became seriously violent. The guests nonetheless managed to escape under adventurous conditions because Lanzmann interpreted the Paluche—more concretely than J.P. Carson had presumably imagined—as a guerilla medium, hurling it with full force at the aggressive Germans.[524]

The Paluche images were in any case already saved for posterity and the archive, since the recorded gestures of the perpetrator were technically never in Coulmas's handbag but had always been sent, transmitted line for line, streamed. Though they captured the bag, the Schuberts had in their hands no tape, no cassette, no storage medium at all, but only the sender, the paw. Nonetheless, the Nazi family sought help at the prosecutor's office in Schleswig-Holstein, who first had to seek the expertise of consultants in order to examine the Paluche's elusive system, and then identify the mysterious phantom »Dr. Claude-Marie Sorel,« ultimately acquiring a court order that prohibited Lanzmann from distributing the footage because the way in which it was acquired amounted to a serious violation of the law: »The worst accusation was that I had used the German air without permission, the German airspace, the German airwaves.«[525] Visual signals, transmitted at high frequency, written line by line, which are able to circulate today as video streams, as completely computerized images, because in 1979, prior to being stored, they were distributed as wave patterns through the airspace in Ahrensburg.

II.3.2 Video Archive Readings

In the course of being incorporated into archives, select materials with a claim to preservation are written into institutionally formatted repositories. Storage and access work together in media logistics. Documenting provenance, itemizing contextual information, producing an apparatus of annotation, and finally embedding items into the relational network of a bureaucratically regulated classification system formulate specifically defined modalities of obstruction and access in the context of a promise of persistence. In order to create transparency about the stored holdings inscribed with long-term guarantees and to keep the archival contents fundamentally accessible, processes of transport

524 For all the scintillating details, see Lanzmann, *The Patagonian Hare*.
525 Ibid.

technology »that aim to combine, connect, reformat, or rescale information« are generally employed.[526] Secure storage is not a passive process, but a »permanent restructuring«[527] that continually produces new differences between archival objects. The archive preserves materials by inscribing itself in them. Access to the archive—which for its part is non-volatile, designed in anticipation of future use—occurs via the production of metadata in a transcription process that transmits the archival arrangement as a code to be called up.

As has already been explained regarding digital databases and streaming technologies, this general archival traffic form is tied to the standards of information management in media technologies. The distribution of archival data proceeds according to protocols, follows administrative rules. The conditions of storage in any given case, like the applicable processes of lending and consultation, are subject to a media-evolutive dynamic that results in the real-time impression provided by low latency in the case of digital ›transfer archives‹ and allows archival usage to produce data in novel ways. Access appears immediately, but in doing so obscures how many technological and infrastructural preconditions the process requires, and what backflow data is stored, how, where, and to what ends. If the storage forms and channel conditions change, the archival data transmission—the microtemporal mode in which a stored document and its metadata are transported into the present of a search request, which for its part is directed according to the demands of storage—is also set in motion, insofar as the corresponding materials are able to appear at new locations, to form different relations, to be accessible to expanded search and reading operations. Before this chapter closes with a look at the more invasive tools of archive-based visual data exploration, we will first consider the broad outlines of the material-specific question of contextualization, namely how the digital redistribution of visibility has impacted the largely retro-converted visual inventory of the Holocaust and its readability.

From the very beginning, engagement with digital moving image archives in media studies has concentrated on popular, essentially user-generated video portals, whose commercialized, social media platform model[528]—thus highly dependent on user data—was paradigmatically contrasted with an

526 Spieker, »Manifesto for a Slow Archive.«

527 Ebeling, Günzel, introduction to *Archivologie*, 18.

528 In general, »platform« here means a form of organizing digital networking. For a sophisticated discussion of the term from the perspective of platform studies, cf. Ian Bogost, Nick Montfort, »New Media as Material Constraint: An Introduction to Platform Studies,« in: Erin Ennis et al. (eds.), *Electronic Techtonics: Thinking at the Interface*, Raleigh, NC: Lulu Press, 2007, 176–192.

archival practice imagined as analog, material, and situated in real space.[529] In the comparison with the archival practices of established institutions—a comparison that has been attempted repeatedly despite all their differences—what was most notable were the dynamics of erosion that not only affect the production and administration of digital reproductions, which are accordingly less permanently protected, but are also related to the massive proliferation of born-digital content, and thus to the problematic archivability of current forms of cultural production and communication: »[…] the size of digital historical archives pales in comparison to the quantity of digital media created by contemporary cultural producers and consumers—designs, motion graphics, websites, blogs, YouTube videos, photos on Flickr, Facebook postings, Twitter messages, and other types of professional and participatory media.«[530] Falling storage costs reduce the pressure on selection and cassation, while there is an increasing need to develop effective information retrieval systems in order to keep the cultural technologies of everyday storage, by now »banal,«[531] open to »information retrieval,« to search and access processes that were traditionally associated with the indexing logic of library and archival classification systems.[532]

In principle, the non-volatile structural dimensions of the archive—materialized, for instance, in the stable depot architecture as well as the

529 Cf. Lovink, Niederer (eds.), *Video Vortex Reader*; Geert Lovink, Rachel Somers Miles (eds.), *Video Vortex Reader II: Moving Images beyond YouTube*, Amsterdam: INC, 2011; Pelle Snickars, Patrick Vonderau (eds.), *The YouTube Reader*, National Library of Sweden, 2009; Patrick Vonderau, »The Video Bubble. Multi-Channel Networks and the Transformation of YouTube,« *Convergence: The International Journal of Research into New Media Technologies* 22/4 (2016), 361–375.

530 Lev Manovich, »How to Compare One Million Images?,« in: David M. Berry (ed.), *Understanding Digital Humanities*, Basingstoke, UK: Palgrave Macmillan, 2012, 249–278, here: 250.

531 »The archive is indeed becoming banal—as it refers more generally to everyday storage needs and the various devices, from portable flash memory drives and external hard drives to cloud computing, in which storage is a new business […]« (Parikka, *What is Media Archaeology?*, 134).

532 Ronald E. Day has theorized the media history of indexing as a transfer of library-archival processes into information-technological systems of »social computing.« Using the term »big social data,« indexing therefore no longer relates only to the document (as a processable container for information), but also to the subject who is searching documents for information and in the course of researching and reading operations is in turn indexed and positioned socially as a ›data point,‹ in relation to indexed user structures (cf. Ronald E. Day, *Indexing It All: The Subject in the Age of Documentation, Information, and Data*, Cambridge, MA: MIT Press, 2014).

implemented taxonomic systems and access barriers—can only to a certain extent be transferred to the software layers of a video portal, which are programmed to be not only easily accessible, but above all regenerative, and thus must be constantly created, encoded, and decoded anew in relation to connection requests, from the automated indexing of the total holdings to the streaming output of a specific video object. Thus Rick Prelinger recently noted a persistent displacement of institutional legacy archives—with particular reference to the moving image heritage[533]—by streaming platforms operated by the private sector, which in many respects function ›anarchivally,‹ but nonetheless have become established as default media archives:

> Archival persistence, digital longevity, and resistance from outside interference are traded in for the appearance of openness, an absence of latency, an omnivorous collecting policy lightly curated if curated at all, and the appearance of near-universal availability. […] we have exchanged the traditional archives for the apparent archives, gaining an appearance of completeness that is in fact full of gaps. As the new archives move into the foreground, the old archives begin to disappear.[534]

As justifiable as this skepticism may be in many respects, it is also noteworthy that there is now a whole series of institutional archival agents developing professional digital agendas. Even in the debate surrounding the self-understanding of archive studies, there has recently been increasing support under the umbrella term »digital historiography« for a shared evaluation of the best practices of genuinely digital archival processes,[535] which have long been the reality in practice. Instead of simply supplying digital reproductions generated within the archive to the dominant portals of commercial providers, institutions such as the USHMM are increasingly maintaining in-house databases and platforms, which have to align the archival material that is made accessible in this way with digital standards of data management technology,

533 On the digitization of this legacy, cf. Sabrina Negri, »Simulating the Past: Digital Preservation of Moving Images and the ›End of Cinema,‹« *Cinéma & Cie: International Film Studies Journal* 26/27 (2016), 45–53, and Franziska Heller, »Digitale Langzeitsicherung: Nachhaltige Verfügbarkeit und Verwertbarkeit von (digitalen) Filmen — Praxen, Erfahrungen, Probleme,« DIASTOR, June 15, 2017, https://diastor.ch/digitale-langzeitsicherung/.

534 Rick Prelinger, »The Disappearance of Archives,« in: Wendy Hui Kyong Chun, Anna Watkins Fisher, Thomas Keenan (eds.), *New Media, Old Media: A History and Theory Reader*, London: Routledge, 2015, 199–204, here: 201.

535 Joshua Sternfeld, »Archival Theory and Digital Historiography: Selection, Search, and Metadata as Archival Processes for Assessing Historical Contextualization,« *American Archivist* 74 (2011), 544–575.

rules of protocol, and formats like JPEG and MPEG, but nevertheless provide it with an institutionally secure locatability.[536] The fact that these reference addresses in turn are not beyond the reach of personalized filter algorithms and the value chains of the attention economy, such as Google's PageRank,[537] is just as obvious as the fact that the newly emerging digital archival architectures cannot operate apart from the general infrastructures of today's data distribution, but rather can only do so on their technological terms. As mentioned earlier, this has given rise to an area of conflict in which institutional agents enter into various processes of negotiation with the surrounding environments of digital transfer storage, which from the perspective of memory studies presents itself as follows: »[…] the third memory boom, with its more immediate, visceral and effervescent digital modes of representation, circulation and connectivity, both sits alongside but also clashes with those modes of representation consolidated by memory institutions.«[538]

Compared to the exponentially increasing data stream volumes of commercial providers, the 40,086 pictures and 9,874 videos that the USHMM web catalog had available for streaming at the time of writing[539] might well be an ultimately secondary distribution of visibility and accessibility—especially the since the material, once it is digitized, can be effortlessly copied and transferred. However, even in relation to earlier spheres of circulation aimed at the culture industry or mass media, institutional image archives were at best marginal distributors, which were required to deliver their stored content to media agents with superior coverage, such as television stations, production companies, newspapers, and magazines if they wanted to create visibility effects with a societal impact.

It is evident that the current circulation of retro-converted archival image material is more dependent than ever on the generally applicable principles of digital image distribution and associated cultural technologies of everyday storage—in terms of the various predominant formats and standards, such as those related to the visual-economic »management and marketing of visibility« within visual culture, which authors like Paul Frosch and Matthias Bruhn have examined from a media archaeology perspective in connection with stock photography and image agencies.[540] Bruhn fundamentally assumes here that »the

536 See also chapter II.2.3.

537 For a critique of the political economy of search engines, cf. Konrad Becker, Felix Stalder (eds.), *Deep Search. Politik des Suchens jenseits von Google*, Innsbruck: Studien Verlag, 2009, and Theo Röhle, *Der Google-Komplex. Über Macht im Zeitalter des Internets*, Bielefeld: Transcript, 2010, 25ff.

538 Hoskins, »Introduction to Digital Memory and Media,« 4.

539 Figure as of August 2017, cf. www.collections.ushmm.org/search.

540 Frosh, *The Image Factory*; Bruhn, *Bildwirtschaft*.

management of image material (that is, organizing, archiving, or analyzing) and the utilization of the same image material (in the sense of its commercial application and sale) are closely related.«[541] In their efforts to become »total archives,«[542] companies that dominate the visual content industry, such as Getty Images, combine commercial photographs (which have faced massive competition from the proliferation of user-generated platforms such as Flickr) and press photo collections with photographic holdings like those of the aforementioned Bettmann Archive, which were extensively digitized in the 1990s by companies like Corbis.[543] But the nexus of management and utilization has in many respects become algorithmically automated or normalized over the course of the general »expansion of the zone of exploitation,«[544] and basically impacts all data objects that are accessible via standardized platforms or are only integrated into the commercially calculated hierarchies of visibility that search engines constantly regenerate and absorb.

Photographic and film documents that are at least partly in the public domain, like the Holocaust images at the USHMM, do not generate any economically relevant trade in licensing rights, but are nonetheless included in the general commodification processes of the net economy like any other datafied cultural object. This also applies to side effects on the interface surface. Anyone who starts typing the term »Auschwitz« in the search field of a video portal like YouTube will be directed, thanks to the autocomplete algorithm, toward »Auschwitz gas chamber,« in some cases after just the letters »Aus« [fig. 27]—and will then arrive, as a random sample shows, at entries that have rather little substance in terms of media historiography, such as »Pictures from Hell,« »Auschwitz—Uwe Boll—Film,« or will very quickly come across those Holocaust deniers who constantly register under new pseudonyms (»Auschwitz Why the Gas Chambers are a Myth«) [fig. 28]. Because the digital restructuring is not only reflected, from the perspective of the user, in obscure algorithmic sortation, questionable »similar videos,« and rather dissimilar amortization signals like advertising banners, but have also led to a boom in historical revisionist appropriations, in recent years problematic activities like

541 Ibid., 9.

542 Frosh, »Beyond the Image Bank,« 132.

543 Cf. Estelle Blaschke, »Bilder als Kapital. Corbis, Getty Images und der digitale Bildermarkt,« *Fotogeschichte* 142 (2016), 49–54.

544 Heilmann, »Datenarbeit im ›Capture‹-Kapitalismus.«

Holocaust denial are increasingly being discussed as net-based phenomena[545] and test cases of an »algorithmic accountability«[546] (Frank Pasquale).

The digital redistribution of the affected visual material is initially manifest as a shift in the attention economy toward the external side of interfaces, guided by the sorting behavior of dominant recommendation and filter algorithms, which increasingly have uncontested control over the power to define center and periphery within visual culture. But in the end what is addressed operationally are the viewing procedures themselves. It is less a matter of a form of commodity tracking that links individual images with the evaluable metadata of a request history, as it was for example in the early Berlin years of the Bettmann Archive—where the relevant customer accounts were initially

545 Cf. Nick Terry, »Holocaust Denial in the Age of Web 2.0: Negationist Discourse since the Irving-Lipstadt Trial,« in: Terry, Paul Behrens, (eds.), *Holocaust and Genocide Denial: A Contextual Perspective*, London: Routledge, 2017. As part of a journalistic research project, Carole Cadwalladr attempted an experiment that applied the economic logic of search engine operators: »The Holocaust did not happen. At least not in the world of Google, it seems. One week ago, I typed ›did the hol‹ into a Google search box and clicked on its autocomplete suggestion, ›Did the Holocaust happen?‹ And there, at the top of the list, was a link to Stormfront, a neo-Nazi white supremacist website and an article entitled ›Top 10 reasons why the Holocaust didn't happen.‹ On Monday, Google confirmed it would not remove the result: ›We are saddened to see that hate organisations still exist. The fact that hate sites appear in search results does not mean that Google endorses these views.‹ And still, anyone searching for information about the Holocaust—if it was real, if it happened, if it was a hoax, if it was fake—was being served up neo-Nazi propaganda as the top result. Until Friday. When I gamed Google's algorithm. I succeeded in doing what Google said was impossible. I, a journalist with almost zero computer knowhow, succeeded in changing the search order of Google's results for ›did the Holocaust happen‹ and ›was the Holocaust a hoax.‹ I knocked Stormfront off the top of the list. I inserted Wikipedia's entry on the Holocaust as the number one result. I displaced a lie with a fact. How did I achieve this impossible feat? Not through writing articles. Or shaming the company into action. I did it with the only language that Google understands: money. […] [Google] has already made £24.01 out of me. (This was the initial cost—it has since risen to £289.) Because this is what I did: I paid to place a Google advert at the top of its search results. »The Holocaust really happened,« I wrote as the headline to my advert. And below it: »6 million Jews really did die. These search results are propagating lies. Please take action.« I did this via Google's AdWords programme. This is the bedrock of everything that Google does, its core business: selling ads against search results. It's this that contributes the bulk of the $5bn profit that Google makes per quarter. AdWords helpfully suggested possible ›Ad group ideas‹ and search terms that included: ›holocaust hoax,‹ ›was the holocaust fake‹ and ›did the holocaust happen.‹ And it told me how many searches a month are made for these terms: all in, 9,480. Or 113,760 a year« (Carole Cadwalladr, »How to bump Holocaust deniers off Google's top spot? Pay Google,« *The Observer*, December 17, 2016).

546 Frank Pasquale, *The Black Box Society. The Secret Algorithms That Control Money and Information*, Cambridge, MA: Harvard University Press, 2015. Cf. also Dourish, »Algorithms and Their Others,« 6ff.

noted by hand on the backs of index cards in the catalog system[547]—than a continuous data return, which flows into the memory banks of portal providers in the ›real time‹ of archive usage in order to be processed in ever finer detail by a data stream algorithm. The images wait indiscriminately for voluntarily self-datafying clients, because at their core providers trade in statistically processed, only superficially anonymized profiles, which can be restored in other data contexts by means of personalized feedback loops and commercially marketed directly as data sets, such as via programming interfaces (API).[548]

This means that, on the one hand, institutional holders of image archives like the NYC Department of Records or the USHMM establish their own addresses and data spaces that provide accessibility to the finding aids, digital reproductions, and pending annotational apparatus by remote access, according to the traditional policy of a self-imposed archival order—which for its part is digitally translated and operable. On the other hand, over the course of these transcriptions, the institutions necessarily adopt the formats, protocols, and processes that link them with the general standards and agendas of digital memory, datafication, and distribution. In this context, a case of »patent trolling,«[549] which became known in 2012, drew attention to the fact that the information-technological restructuring of institutional archives is not exclusively being carried out using commercial software programs and tools, but in some cases can also involve thoroughly innovative in-house developments. Between 1996 and 2002 the Shoah Foundation Visual History Archive secured

547 Blaschke, *Banking on Images*, 117.

548 »The Google search engine and commercial social media platforms such as Facebook, Twitter, YouTube and Instagram continually generate data from the interactions of millions of users. Access to data/tools is sold to marketeers and is employed to target, predict and manage these platforms' users. So-called application programming interfaces (APIs) make parts of vast databases accessible to third parties, including researchers. Concurrently, an industry has emerged whose companies collect, sell, combine and analyse data sets for all kinds of purposes, ranging from targeted advertising and market research to credit ratings, risk assessments and mass surveillance. The collection of data from massive data sets also yields a glimpse of a future when certain sorts of businesses will thrive on the exploitation of vast amounts of stored information« (Karin van Es, Mirko Tobias Schäfer, »Introduction: New Brave World,« in: van Es, Schäfer (eds.), *The Datafied Society. Studying Culture through Data*, Amsterdam: Amsterdam University Press, 2017, 13–24, here: 14).

549 The background is explained in: Mike Masnick, »Holocaust History Preserver Shoah Foundation's Patents Being Used to Sue Google, Facebook, Hulu, Netflix, Amazon,« TechDirt (blog), March 14, 2012. https://www.techdirt.com/articles/20120310/01381118066/holocaust-history-preserver-shoah-foundations-patents-being-used-to-sue-google-facebook-hulu-netflix-amazon.shtml.

ten patents related to database management of multimedia content. Some of these were adopted and further developed by the industry, as Todd Presner contends in a detailed examination of the IT architecture of the most extensive video archive of witnesses in the world: »Some of the patents—such as the ›Digital Library System‹ and ›Methods and Apparatus for Management of Multimedia Assets‹—have been referenced by more than seventy other patents from companies such as Xerox (for developing a browser-based image storage and processing system) and Microsoft (for semiautomatic annotation of multimedia objects).«[550] Fundamentally, it can probably be said that the marking and operation of boundaries, the distinction between an »archival interior and its non-archival exterior«[551] is starting to erode: first in terms of media technology, but also with regard to concrete archival holdings. This gives rise to sometimes depreciative, ›anarchivally‹ polarized adjacencies of collections, only partially predictable dynamics of exchange and duplication, which from an institutional perspective are potentially undesirable, but de facto can hardly be restricted.

The concomitant effects, however, also converge with the interests of public institutions in maximizing visibility and reach for purposes of generating institutional legitimacy. The USHMM, for instance, like many comparable institutions, has maintained its own YouTube channel since 2006,[552] with content drawn from its digitized archival holdings. But while the exhibits for this channel may well be carefully selected, once they are uploaded they inevitably become subject to the provider's proprietarily protected filtering, recommendation, and personalization algorithms, and are thus sortable, for instance, according to popularity, upload date, etc. The selected exhibits can usually also be incorporated into any given website through hotlinking (framing & embedding), and are consequently interconnected with more or less appropriate web ads as well as »similar videos,« which the USHMM has no curatorial influence on whatsoever. New visual adjacencies therefore arise not only due to the activities of infrastructural agents such as search engine providers, which transport, for example, historical footage of liberated concentration camps into direct proximity with a viral social media phenomenon such as that of the

550 Todd Presner, »The Ethics of the Algorithm: Close and Distant Listening to the Shoah Foundation Visual History Archive,« in: Claudio Fogu, Wulf Kansteiner, Todd Presner (eds.), *Probing the Ethics of Holocaust Culture*, Cambridge, MA: Harvard University Press, 2016, 175–202, here: 189.

551 Spieker, »Einleitung: Die Ver-Ortung des Archivs,« 8.

552 Cf. https://www.youtube.com/user/ushmm.

»Auschwitz Selfie-Girl Princess Breanna.«[553] In the final analysis, this conceals a fundamental conflict that the institutional organizations have to negotiate in particular when engaging with the digitization dynamics of social media, which they de facto conform to and support, while simultaneously attempting to resist them as archival authorities and gatekeepers: »[…] institutions of Holocaust memory […] have played an admirable, even pioneering role in digitizing the Holocaust culture and creating searchable databases, but they have kept a fearful distance from truly open, interactive, web-based media formats or exposing their data to the World Wide Web. In this regard, digital Holocaust Culture is at odds with popular digital culture whose users are driven by the ability to shape content in the process of consumption.«[554]

Hierarchies among archival holdings, their taxonomic classification, the internal coherence of a collection's unity tend to unravel here in favor of increased mobility and uncontrollable operations of recontextualization. The result is increasingly long chains of transmission and the proliferation of temporary storage. Fed into popular video portals, the material is consigned to a black box technology whose emergent effects facilitate careers of visibility with no counterpart in the internal digital spaces of established archives, but which nonetheless have a kind of official address there, a horizon of referentiality. Considered in terms of media logistics, however, the officially documented archival materials still stream through the same transmission channels as all other data, whose provenance and claims to validity have as a rule not undergone any institutional clarification processes.

The notion of a predetermined ›deprofessionalization‹ of the institution due to a complete dependence on market dynamics that are aimed, not at institutional needs, but primarily at the economic logics of social media platforms, underestimates at least the remaining regime of boundaries that separate institutionally coded practices from others. Nevertheless, against the backdrop of an empirically certain dominance of distributional calculations that operate according to the standards of commercial automatization, it can be observed that Holocaust image collections are being ›de-embedded‹ from their previous circulation histories, locations, and usage contexts, have become raw materials that are framed and accessible in different ways. This

553 Jay Hathaway, »Teen Wants Everyone to Stop Bugging Her About Smiley Auschwitz Selfie,« *Gawker*, July 21, 2014, https://www.gawker.com/teen-wants-everyone-to-stop-bugging-her-about-smiley-au-1608404560. On the phenomenon of concentration camp selfies, see also Sergej Loznitsa's documentary AUSTERLITZ (2016), which observes the initial moment of the circulation history of such images in view of the dominant visual practices at the concentration camp memorials Sachsenhausen and Dachau.

554 Fogu, Kansteiner, Presner, »Introduction,« 33f.

not only elicits dynamics of monetization that have been largely criticized,[555] but in some cases can also involve a revalidation of the source status.

This applies, for example, to the USHMM's archivally processed SHOAH outtakes. On the one hand, they are somewhat unknown and undistributed, that is, ›unconsumed,‹ and on the other hand, from the viewpoint of witness theory and the culture of memorializing, in the image of the perpetrators they contain a specifically problematic, comparatively marginal sort of document, which requires additional efforts at contextualization in generic usages as well. The SS men are questionable as witnesses not only because they tend to deny their actions, but also because their crimes were expressly aimed against the principle of bearing witness. The perpetrators' extraordinary frenzy of extermination and eliminating traces—perpetrators who did not wish to see their actions documented and yet constantly generated bureaucratic paper trails, even operating as image producers[556]—was essentially aimed, as is discussed extensively in the pertinent discourses of visual theory, at »fragmenting eyewitness testimony itself.«[557]

The aspect of revalidation involved in the digital conversion, however, can be seen above all in the most intensely widespread visual documents of the Holocaust, those images by Soviet, British, and American camera teams, often described today as ›iconic,‹ that depict on film the horrible conditions in the concentration and extermination camps at the historical moment of their liberation.[558] This was: »Filming without knowing, filming without comprehending. Filming to see, later on, in the aftermath of history,«[559] as Jean-Louis

555 Cf. Ramon Lobato, »The Cultural Logic of Digital Intermediaries: YouTube Multichannel Networks,« *Convergence: The International Journal of Research into New Media Technologies* 22/4 (2016), 348–360.

556 Alongside the continuous creation of Nazi propaganda material, we should also mention private amateur photographs such as the 116 photographs of the Höcker Album (»Auschwitz Album«), also archived at the USHMM and named for the SS *Obersturmführer* Karl-Friedrich Höcker, who captured the festive celebrations and leisure activities of the SS camp staff between June 1944 and May 1945 while during the same timeframe, beyond the frames of these images, 400,000 Hungarian Jews were being murdered. A US Army soldier found the album in 1946, in 2007 it came into the holdings of the USHMM, and today the digitized photographs can be retrieved in the web catalog (»SS Auschwitz album,« Accession Number: 2007.24, Permanent Collection, USHMM, https://collections.ushmm.org/search/catalog/irn518658).

557 Felman, »Im Zeitalter der Zeugenschaft,« 181.

558 On the following, cf. Simon Rothöhler, »Lagerbefreiungsbilder. Materialbefunde,« *Merkur. Deutsche Zeitschrift für europäisches Denken* 791 (04/2015), 61–68.

559 Jean-Louis Comolli, »Fatal Rendezvous,« in: Jean-Michel Frodon (ed.), *Cinema and the Shoah: An Art Confronts the Tragedy of the Twentieth Century*, New York: SUNY Press, 2010, 55–70, here: 65.

Comolli noted with regard to MEMORY OF THE CAMPS, an early edited version of the Allied film material, shot by camera operators without professional training who were shocked at the sight of the gruesome reality of German extermination politics, including Arthur Mainzer (Buchenwald), George Rodger (Bergen-Belsen), and Alexander Vorontsov (Auschwitz-Birkenau).

In the archive at the USHMM there are currently 360 entries under »[Photo/Film Keyword] Concentration Camps (Liberation),« including numerous unedited scenes from Bergen-Belsen and Buchenwald, as well as streaming videos with footage from less familiar camps like Arnstadt, Nordhausen, Ohrdruf, and Imhoff.[560] The distribution history of the camp liberation images, which now reaches back more than seventy years and can itself be considered from a historical perspective, begins with the circulation of compiled excerpts initially presented as evidence at the Nuremberg Trial of the Major War Criminals and later used in other situations, for reeducating or »shaming«[561] (Ulricke Weckel) the perpetrator society. Over the course of the 1950s the material more or less completely disappeared from the public sphere. Not until the end of the 1970s, after the global broadcast of the NBC miniseries HOLOCAUST, which Claude Lanzmann and Pery Broad talk about in »Film ID 3438,« did the archival images of the camps' liberation re-emerge—as a central element of the »Holocaust iconography«[562] that would soon become consolidated in mass media.

The initial formatting of the material lay nearly three decades in the past at the time of this ›rediscovery.‹ Long before televisual recycling—which represented the dominant form of the material's media visibility in the last few decades, before digital video portals began to assert themselves as default media archives—the visual material found its way into a variety of newsreel-style programs like the British MOVIETONE NEWS (»Atrocities—The Evidence« [UK 1945]) and a series of early documentaries, the first of which include: VERNICHTUNGSLAGER MAJDANEK — CMENTARZYSKO EUROPY (USSR/Poland 1944, Aleksander Ford), OSWJENZIM (USSR 1945, Jelisaweta Swilowa), DEATH MILLS/DIE TODESMÜHLEN (USA/Germany 1946, Billy Wilder and Hanuš Burger). Many of the sequences made public immediately after the liberation within the context of three institutional frameworks—courts, POW camps, movie theaters—have since been integrated so often in various audiovisual montage contexts that the general degradation of the

560 Cf. https://collections.ushmm.org/search/advanced.

561 Ulricke Weckel, *Beschämende Bilder: Deutsche Reaktionen auf alliierte Dokumentarfilme über befreite Konzentrationslager*, Stuttgart: Franz Steiner Verlag, 2012.

562 Fogu, Kansteiner, Presner, »Introduction,« 7.

impact of the documentary content in terms of reception aesthetics—and here that means not least its ›iconicity‹—has to appear at least as a side effect of precisely this routine incorporation in media. If this image material can be »called up« (Gitelman) today completely casually and from practically anywhere on any screen, ubiquitous data transfers also entail a turning point from the perspective of the history of distribution.

As is well-known, this history began in court: Already at the first public screenings—on September 20, 1945, in the Lüneburg Bergen-Belsen Trial, and on November 29, 1945, at the Nuremberg »imaging process«[563]—the footage was introduced as more or less self-evident proof whose documentary status seemed to be exhaustively clarified with the sworn statements of the camera operators, with no need for further information about contexts or provenance to enter the record. The Trial of the Major War Criminals was indeed about »creating a foundation of documents,« as Cornelia Vismann has shown. But this was addressed primarily to the global public, with the goal of »creating a canonical reference.«[564] The history of the camp images becoming iconic as »emblems of the Holocaust«[565]—a history that has now arrived at the automatic replay mode of video portals—also begins in court insofar as it was called to the witness stand, but was not questioned further.[566] Furthermore, the cameras in court were not aimed at documents, but at the perpetrators, who were meant to enter into the history of the image of the perpetrator as recipients of crime scene images: »This mixture of what was shown and the reaction to it is part of the legacy of Nuremberg, is perhaps the entire legacy of Nuremberg. Ultimately the trial did not just canonize certain images from the concentration camps. First and foremost, it canonized the viewing of the footage from the concentration camps, by drawing the spectator's gaze away from the screen and, with skillful lighting control, directing it toward [the perpetrators] as they watched the film.«[567] Seen in this way, it is not just the visual documents that were intended to be passed down for posterity, but rather a normative relation of viewing, which for its part could be archived

563 Vismann, *Medien der Rechtsprechung*, 241.

564 Ibid., 245.

565 Ibid., 254.

566 Cf. Lawrence Douglas, »Der Film als Zeuge. Nazi Concentration Camps vor dem Nürnberger Gerichtshof,« in: Ulrich Baer (ed.), *›Niemand zeugt für den Zeugen‹. Erinnerungskultur nach der Shoah*, Frankfurt am Main: Suhrkamp, 2000, 197–218.

567 Vismann, *Medien der Rechtsprechung*, 258.

and distributed from then on as documentary,[568] as the courtroom image of a »confrontation.«[569]

By contrast, current access via the streaming archive at the USHMM presents the opportunity for a rediscovery[570] of the footage, not as documents of a viewing, but as visual documents: as concrete source material, which is to be read in its historical conditionality and has been evaluated astonishingly rarely (and only very late) with appropriate historiographic meticulousness.[571] Freed from the formal-illustrative usages predominant particularly in the montage practices of historical television, while simultaneously distanced from commercial video portals with their primarily ›user-generated‹ clips, which for their part

568 In the image-theoretical discussion of concentration camp images, there was from the beginning a formative strand of discourse that negotiated distributive effects under reception-ethical auspices (cf. Rothöhler, *Amateur der Weltgeschichte*, pp. 143ff.). Already Siegfried Kracauer's famous twist on the Perseus myth–Kracauer speaks of »mirror images« whose »appearance on the witness stand [redeems] the horrible from its invisibility behind the veils of panic and fantasy« [»Spiegelbilder«, deren »Erscheinen im Zeugenstand« das »Grauenhafte aus seiner Unsichtbarkeit hinter den Schleiern von Panik und Fantasie [erlöst]«] (Siegfried Kracauer, *Theorie des Films, Werke Band 3*, Frankfurt/Main: Suhrkamp, 2005, p. 467ff.)–ties the, in Adorno's words: model »of a withstanding within the image« [Standhalten im Bilde] (Theodor W. Adorno, Siegfried Kracauer, *Briefwechsel* 1923–1966, Frankfurt/Main: Suhrkamp, 2008, p. 688) to the figure of thought of an effective media-technical transmission. Cf. also Shoshana Felman's theoretical modeling of what Ulrich Baer has called a »second witness community« (Felman, »Im Zeitalter der Zeugenschaft«) and Georges Didi-Huberman, *Bilder trotz allem*, Paderborn: Fink, 2007, pp. 81–133.

569 Vismann, *Medien der Rechtsprechung*, 249.

570 This rediscovery has to do in part with digital restoration projects (one example would be German Concentration Camps Factual Survey), which acquire in some sense ›new images‹ by removing visual signs of aging from the much-used celluloid material (cf. Rothöhler, »Lagerbefreiungsbilder«).

571 Historians of photography began doing this in the mid-1990s: Marie-Anne Matard-Bonucci, Edouard Lynch (eds.), *La Libération des camps et la retour des déportés*, Paris: Editions Complexe, 1995; Clément Chéroux (ed.), *Mémoire des camps: Photographies des camps de concentration et d'extermination nazis (1933–1999)*, Paris: Marval, 2001; Janina Struck, *Photographing the Holocaust: Interpretations of the Evidence*, London: Tauris, 2003. For the film material, exceptions include Sylvie Lindeperg's analysis of the intricately interwoven layers of material in Alain Resnais's Nuit et Brouillard [Night and Fog] (Sylvie Lindeperg, *»Nacht und Nebel«. Ein Film in der Geschichte*, Berlin: Vorwerk 8, 2010), as well as a work like Harun Farocki's Aufschub [Respite] (2007), which adopts the mode of a film-analytical practice of source-critical recontextualization in its focus on footage from the Dutch concentration camp Westerbork, which the Jewish inmate Rudolf Breslauer was forced to film in 1944 under the supervision of SS *Obersturmführer* Konrad Gemmeker (cf. Florian Krautkrämer (ed.), *Aufschub. Das Lager Westerbork und der Film von Rudolf Breslauer/Harun Farocki*, Berlin: Vorwerk 8, 2018).

were simply extracted from televisual formats, these images now also circulate with the attached finding aids of digital archives. With this, in addition to reconstructing the respective item's circumstances of production, the archival metadata historicizes the visual material in terms of its history of reception and distribution.[572]

Alongside continuities in the history of usage that, to this day, program the visual Holocaust material into historical television formats as dereferentialized, fictionally invoking and diffusing it, the last few years have thus seen increased media (counter-)transmissions originating from institutions like the USHMM or Yad Vashem. Critiques of social media practices of duplication and appropriation, which usually rest on a foundation of cultural pessimism, often overlook the fact that the footage, consolidated as archival images with institutional insistence, no longer circulates only as the template for pop-cultural migration and platform content, but for the first time also as non-compiled visual documents: as primary sources in need of historiographical interpretation, to be considered individually, associated with different historical origins—sources that were previously accessible, if at all, only by exclusively authorized, elaborately prepared visits to the archive.

What now become visible, after the digitization of the archive, are not least those areas of the material as a whole that remain marginal within the attention economy—in relation to the previous empirical history of distribution, one can generally speak here of a counter-canonical disclosure of numerous outtakes—as the full collection has been narrowed down over the course of its recycling, first by the History Channel, then by commercially operated

572 Tobias Ebbrecht-Hartmann has suggested the following periods: »›Evidence‹ (the footage from the camps and the propaganda images of the National Socialists) became ›documents‹ (for instance in the compilation films of the 1950s and 1960s) and finally archival images, which began migrating into various media as well as popular culture and art« (Tobias Ebbrecht-Hartmann, »Das Gedächtnis des Archivs. Die Erinnerung an den Holocaust im Non-Fiction-Film,« in: *Asynchron. Dokumentar- und Experimentalfilme zum Holocaust*, Arsenal — Institut für Film- und Videokunst e.V. 2015, 26–32, here: 28). In SON OF SAUL (2015), this migration, which strives to disclose ever new aesthetic registers, has directly arrived at those »images in spite of all« (Georges Didi-Huberman), whose production history is visually alluded to and hyper-concretely enriched in the audio of Lázló Nemes's Auschwitz film. The symbolically mediated entry of the image inventory into contexts of a globalized culture of memory, far removed from the events themselves, also seems to be unwavering (cf. Daniel Levy, Natan Sznaider, *The Holocaust and Memory in the Global Age*, Philadelphia: Temple University Press, 2005). On the »postmemorial« turn cf. Aleida Assmann, »Transformations of Holocaust Memory. Frames of Transmission and Mediation,« in: Gerd Bayer, Oleksandr Kobrynskyy (eds.), *Holocaust Cinema in the Twenty-First Century: Images, Memory, and the Ethics of Representation*, New York: Columbia University Press, 2015, 23–39).

video portals, to a handful of scenes that have shifted, in part precisely through constant repetition with no source citation, into the often lamented state of ›iconic‹ illegibility, at least tendentially.[573]

As soon as the materials become available in digital form, the question arises as to their (un)readability as historical documents on the infrastructural basis of a transport system whose channels render the datafied footage specifically calculable and distributable. The transfer into digital archives has a different significance than feeding images into discrete circuits that can be completely sealed off. Instead, it creates information-technological connections that expand the potential for circulation. Within the extensive visual culture that has accumulated around the historical event and context of the Holocaust in fictional-simulating and documentary registers, the media logistics of computer networks also opens up bodies of archival images to contingent relations, patterns of interpretation, adjacencies. As a retro-converted data set, the source material not only becomes more versatile in terms of distribution, it also becomes accessible to expanded operations of image processing.

II.3.3 Computing Video Archive Data

Within Digital Humanities, the implications of these novel registers of informational ›readability,‹ and how access can be programmed as invasive, are now also being discussed in relation to the associated potential for analyzing images.[574] Against the backdrop of a media transformation of the entire archive

573 In the context of material research for his found footage film about the Westerbork concentration camp, Harun Farocki gets to the heart of this point: »Because we have to take historical images seriously. These images are often heavily compiled on TV, therefore losing their value as documents. Compilation—which is of course a respectable term for looting—precisely with the footage from the camps has resulted in no one knowing what these images are: Are they reenactments? Are they images from fictional films? Who shot them and why?« (Harun Farocki, »Filmemacher Harun Farocki über das KZ Westerbork: ›Bilder wie eine Flaschenpost,‹« interview by Stefan Reinecke and Christian Semler, *taz,* July 1, 2008).

574 The most advanced discussion here seems to be taking place in art history—from the question of machine readability of images (such as for automated keywording and comparative style analysis) to those visual infographics that the Digital Humanities itself creates as products of its own data visualization practices; cf. Stefan Heidenreich, »Form und Filter — Algorithmen der Bildverarbeitung und Stilanalyse,« *zeitenblicke* 2/1 (2003), and Katja Kwastek, »Vom Bild zum Bild — Digital Humanities jenseits des Textes,« *Zeitschrift für digitale Geisteswissenschaften*, February 19, 2015. For more recent approaches, beyond art history, see the projects of the Special Interest Group AudioVisual Material in Digital

of cultural artifacts—David Berry speaks of »cutting up the archive«[575]—the question of distribution is largely a matter of computer-based procedures of digital image searching and categorization. Considering the IT architecture of the Shoah Foundation Visual History Archive (VHA), Todd Presner has raised the question of what kind of »computational genre« is involved here, and what that implies: »What would it mean for a computer to ›watch,‹ ›hear,‹ and ›listen‹ to testimonies? What might be seen or heard beyond the faculties of human cognition and the optics of human perception?«[576]

These videos are able to be used operationally as database material in the first place, however, above all because human agents performed a manual indexing of the entire collection. In the course of this work, an institutionally controlled, consistent thesaurus was generated according to prescribed

Humanities (cf. https://www.avindhsig.wordpress.com). An interesting »Distant Viewing TV« approach focuses on surveying the ›big data‹ of American television history: »Distant Viewing TV (distanttv.org) applies computational methods to the study of fourteen series from the Network Era of American Television (1952–1985), utilizing and developing cutting-edge techniques in computer vision to analyze moving image culture on a large scale. Given that long-running television series broadcast hundreds of episodes, and the major networks run dozens of series each season, previous studies of network television have had to rely on a close analysis of a subset of series, episodes, and scenes […]. Distant Viewing TV builds off of this scholarship by applying computational approaches, specifically machine learning techniques, that can analyze the contents of tens of thousands of hours of television programming« (Taylor Arnold, Lauren Tilton, »Distant Viewing TV,« AVinDH SIG (website), https://www.avindhsig.wordpress.com/distant-viewing).

575 »The digital humanities also try to take account of the plasticity of digital forms and the way in which they point towards a new way of working with representation and mediation, what might be called the digital ›folding‹ of memory and archives, whereby one is able to approach culture in a radically new way. To mediate a cultural object, a digital or computational device requires that this object be translated into the digital code that it can understand. This minimal transformation is effected through the input mechanism of a socio-technical device within which a model or image is stabilized and attended to. It is then internally transformed, depending on a number of interventions, processes or filters, and eventually displayed as a final calculation, usually in a visual form. This results in real-world situations where computation is event-driven and divided into discrete processes to undertake a particular user task cultural object. The key point is that without the possibility of discrete encoding there is no cultural object for the computational device to process. However, in cutting up the archive in this manner, information about the archive necessarily has to be discarded in order to store a representation within the computer. In other words, a computer requires that everything is transformed from the continuous flow of everyday life into a grid of numbers that can be stored as a representation which can then be manipulated using algorithms« (David M. Berry, »Introduction: Understanding the Digital Humanities,« in: Berry (ed.), *Understanding Digital Humanities*, Basingstoke, UK: Palgrave Macmillan, 2012, 1–20, here: 2).

576 Presner, »The Ethics of the Algorithm,« 184.

guidelines for identifying and keywording content. Because the language content of the videos, the verbalized witness narratives, had not yet been transcribed—which was already within the realm of the mechanically possible with language recognition software—the indexing process was not able to rely on automatic tagging operations, which should be understood not only as a lack of modernization, but also as inscribing and maintaining archival authority, given that practices of professional classification by human agents—fifty archive employees were working on it for several years—ensure an accordingly privileged first access. The roughly 52,000 videos were discretized into one-minute information units, which were to be ascribed keywords using the hermeneutic interpretative capacities of the archivists (occasionally no keyword was to be assigned, which generally indicates continuity with the keyword from the previous minute). Presner describes this enormously time-consuming process of datafication as an operation of subtraction, which abstracts from certain information in the audiovisual material because it cannot extract it:

> The result is a massive data ontology that has expelled the latent content, the performative, the figural, the subjunctive, the tone of questioning and doubt, the expressiveness of the face, and the very acts of telling (and failing to tell) that mark the contingency of all communication. […] In other words, what goes missing in the ›pursued objectivity‹ of the database is narrativity itself […] Of course, this is because databases are not narratives or people telling stories; they are formed from data (such as keywords) arranged in relational tables that can be queried, sorted, and viewed in relation to tables of their data.[577]

On the other hand, the indexing of the archival database also adds informational resources in the form of metadata, which, in addition to nonlinear access modes and equally accelerated and granularly resolvable search processes, facilitate significantly expanded sorting capabilities, allowing the entire holdings to be scalable in new ways and potentially intelligible by means of digital humanities tools of data visualization: »seeing connections that a human eye could not possibly detect or track.«[578] The thesaurus contains a metadata network of words comprising around 50,000 different keywords, which is not only able to search for individual keywords, but can also be visualized as network graphs showing the relations between data sets—an algorithmic distant

577 Ibid., 192–193.
578 Ibid., 194.

reading of the material meant to reveal patterns and provide a visual way to grasp, if not meaningful connections, at least the centers and peripheries of the keywording.[579] The fact that this database-driven quantification also gives rise to ethically problematizable modes of ›distant‹ readings—such as when survivors of the Shoah become flattened as »data points« and pixels of rasterized data visualizations—can be offset, in Presner's view, by a kind of computer driven big-data ›égalité‹: »[C]omputational or algorithmic analysis can be ethical precisely because it takes into account the fullness of the archive insofar as all the indexed data related to the narrative of every survivor is part of the analysis.«[580]

Notwithstanding such archive-ethical evaluations, there is the additional question of the incipient performance parameters of algorithmic image recognition beyond manually constructed networks of words, which point the way for automated, »non-human storage readings« (Wolfgang Ernst), but are primarily intended to make it possible to filter the ambient information overload that has arisen due to the constant proliferation of digitally ›born‹ stored material. Initially, readability here is meant in a less semantic sense than the term suggests. The automated processes of dealing with image data are first and foremost a matter of optimizing their organization and classification. ›Reading‹ here denotes a computerized act of managing storage, meant to create an overview, to moderate access. What is read, strictly speaking, are values and statistics: »›Reading‹ an image as part of a pictorial tradition can be complemented or even replaced by processing images as data.«[581]

The hope, already expressed repeatedly at the beginning of the 2000s, that information technology will supplant the logocentric »hegemony of the word in visual memory«[582] occasionally returns in this discursive context as a big-data utopia of quantitative, ›distant‹ reading modes, which, with sheer data

579 Presner demonstrates this point with the open-source application Gephi (gephi.org); cf. ibid., 194ff. Also of interest in this context is his reference to the epistemological potential of a »more fluid« datafication: »For example, what if verbs that connected action and agent, experience and context were given more weight than hierarchies of nouns primarily in associative relationships? What if a more participatory architecture allowed for other listeners to create tags that could unsay the said, or in other words, undo—or, at least, supplement—the definitive indexing categories and keywords associated with the segmented testimonies?« (ibid., 200).

580 Ibid., 199.

581 Scott McQuire, »Digital Photography and the Operational Archive,« in: Sean Cubitt, Daniel Palmer, Nathaniel Tkacz (eds.), *Digital Light*, London: Open Humanities Press, 2015, 122–143, here: 129.

582 Ernst, Heidenreich, Holl, »Editorial. Wege zu einem visuell adressierbaren Bildarchiv,« 8.

volume, promise to drive out both the spirit of canonizing the same old works in hermeneutic close readings[583] and the concomitant routines of cultural-historical periodization. In this vision, more data, stored digitally, processed by computers (and then, however, visualized again for people pursuing academic agendas), recalculate a world history of culture that is inclusive of the peripheries of the long tail and is not only based on a broader empirical database, but also more objective in terms of its processing because it is less dependent on individual or institutionally reproduced interpretations and their dependencies on a certain location, instead detecting divergent patterns without any previously invested qualitative bias. At least, that is the promise.

Popularized in an application that traces trajectories of the history of word usage through historical space, such as Google's NGram Viewer[584]—which in German-speaking areas indicates a curve for the example term »Holocaust« that reached its peak in 1985, the year that SHOAH was released, and currently has almost sunk again to the significantly lower level of around 1961—the problem, from the perspective of visual theory, is a priori much more complex:

> But between the endless columns of figures and the shapes that a human gaze recognizes there is a gaping chasm. The difference, which is constitutive for all technological media—namely, that they function precisely when they hide their raw data and replace them with imaginary illusions—continues in the algorithms that are meant to address pixelated images or to recognize something in them. On the one hand there are raw data that encode the images as fields of colored pixels; on the other there is a perception that cannot help but see something: faces,

583 The salient citation on this point by the literary scholar Franco Moretti reads: »[…] a canon of two hundred novels, for instance, sounds very large for nineteenth-century Britain (and is much larger than the current one), but is still less than one per cent of the novels that were actually published: twenty thousand, thirty, more, no one really knows—and close reading won't help here, a novel a day every day of the year would take a century or so. […] And it's not even a matter of time, but of method: a field this large cannot be understood by stitching together separate bits of knowledge about individual cases, because it isn't a sum of individual cases: it's a collective system, that should be grasped as such, as a whole« (Franco Moretti, *Graphs, Maps, Trees: Abstract Models for a Literary History*, New York: Verso, 2007, 3–4). On the distant reading approach, cf. Kathleen Fitzpatrick, Alexander Galloway, James F. English, »Franco Moretti's ›Distant Reading‹: A Symposium,« *Los Angeles Review of Books*, June 27, 2013, and Steffen Martus, »Weltliteratur gescannt,« *Die Zeit*, August 8, 2016.

584 Cf. https://books.google.com/ngrams. For a critique of the NGram Viewer as a black box, cf. Charles R. Acland, Eric Hoyt, Kit Hughes, »A Guide to the Arclight Guidebook,« in: Charles R. Acland, Eric Hoyt (eds.), *The Arclight Guidebook to Media History and the Digital Humanities*, Sussex: Reframe Book, 2016, 1–29, here: 16f.

> people, rooms, objects. Only very gradually are the processes of digital viewing machines beginning to find visual objects in the fog of fields of numbers.[585]

What the computer ›sees‹ in images can actually at best be answered in a figurative sense, if only because calculations operationalized step-by-step cannot really be accounted for with a perceptual impression. The problem with »semantics in the process of semiosis,« which the computer, being ›indifferent to meaning,‹ does not recognize because it operates »purely syntactically,«[586] is not exactly diminished by models that must temporally sequence and spatially segment image processing.

Already with the early forms of CAPTCHA (Completely Automated Public Turing test to tell Computers and Humans Apart), it becomes clear that, due to their relative machine unreadability, data objects that appear to human perception in a subjectively unproblematic, intuitive, direct way as images *of something* can be repurposed, even serving as security prompts. The reading barrier here takes the form of image filters that present distorted series of letters or simple math problems, whose graphic image surfaces have no directly readable counterpart in the stored ›raw data‹ of the image file. Google's reCAPTCHA[587] ultimately drew the reverse conclusion for the benefit of their own digitization plans, taking the millions of daily verifications that users are not robots[588] and applying them to scanned words that cannot be processed correctly by text recognition software. While serial image content recognition puzzles as well as video and audio captchas continue to be used to protect against automated spambots,[589] Google now prefers to feed street signs and house numbers into the reCAPTCHA widget in order to have an army of volunteers, working anonymously, correct the deficits in the database of its mapping service.

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585 Ernst, Heidenreich, Holl, »Editorial. Wege zu einem visuell adressierbaren Bildarchiv,« 11.

586 Martin Warnke, »Bildersuche,« *Zeitschrift für Medienwissenschaft* 1 (2009), 29–37, here: 30.

587 Cf. https://developers.google.com/recaptcha.

588 Cf. Ayhan Aytes, »Return of the Crowds: Mechanical Turk and Neoliberal States of Exception,« in: Trebor Scholz (ed.), *Digital Labor: The Internet as Playground and Factory*, New York: Routledge, 2012, 79–97, and Suphannee Sivakorn, Jason Polakis, Angelos D. Keromytis, »I'm not a human: Breaking the Google reCAPTCHA,« Black Hat ASIA, 2016, https://www.blackhat.com/asia-16/briefings.html#im-not-a-human-breaking-the-google-recaptcha.

589 Cf. Robert Gehl, Maria Barkardjieva (eds.), *Socialbots and their Friends: Digital Media and the Automation of Sociality*, New York: Routledge, 2017.

Lisa Gitelman has more closely examined this model of positioning digital images as resistant barriers to ubiquitous machine readability in her study on the text image pages of Portable Document Files:

> If it is a commonplace today that words and images and sounds are closer together than they have ever been before—now that all of them come as data strings, in bits and bytes—nonetheless there are important ways that ›as computational data structures, images differ radically and fundamentally from electronic text.‹ The big difference, as Kirschenbaum explains, is that unlike digital text, ›images remain largely opaque to the algorithmic eyes of the machine.‹ Images cannot be searched internally as text files can. Search Google Images or Flickr all you like: you are effectively searching associated tags—textual metadata—rather than actual images. [...] Optical character recognition points precisely to the line that separates electronic texts from images. It is a line that disappears at the level of the alphanumeric character since ›the algorithmic eyes‹ of scanning technology effectively identify the shapes of characters, ›seeing‹ them as patterns of yes/no variables that can together be ›recognized‹ (that is, processed) as alphanumeric characters. Image searching is an intensely hot area for research—think of facial recognition technology, fingerprint analysis, or Google Goggles—but for everyday users, OCR is as close and as necessary as it gets.[590]

The assertion that the most easily readable image from the perspective of the computer is the image of a digitally scanned letter, however, is a matter of a provisional technological state—not only because of ongoing developments, but also in terms of conceptual history, insofar as several levels could be distinguished on which computers are able to apply the process that is then defined as ›reading.‹ Birgit Schneider, discussing the Jacquard machine's punch cards, already assumes that the weaving pattern transformed into visual code thereby became »processable and machine readable.«[591] By contrast, the reading process is currently considered primarily against the more demanding background of the »semantic gap«[592]—a gap which is expected to be gradually

590 Gitelman, *Paper Knowledge*, 134.

591 Berz, Schneider, »Bildtexturen,« 200.

592 »This is the gap between knowledge that a human being can extract from some data, and how a computer sees the same data. For example, looking at a photograph of a person, we can immediately detect that the photo shows a human figure, separate the figure from the background, understand what a person is wearing, face expression, and so on. But for a computer, a photograph is only a matrix of color pixels, each pixel defined by three

closed primarily by processes of learning algorithms on the basis of artificial neural networks. In the context of machine learning, processing that ›reads‹ does not simply refer to the automatic processing and distributed reproduction of visual patterns. The goal of reading is to recognize the contents of the image.

In the history of the image archive, the question of image recognition operations relevant to administrative pragmatics already turns up at an early stage in the context of optimizing search processes. Identification, as a prerequisite for indexing and cataloguing, serves first and foremost to improve retrievability. The continual growth of archival holdings—particularly since digital technologies of image acquisition and storage have become established—produces an increasing pressure to not only systematize and unify processes of recognition, but also to automate them. What can be seen on an image, how to hierarchize the detected objects (and, more generally: ›contents‹) that are related to each other in various ways, and if necessary to tag them with keywords, becomes a problem of the archival economy. Processes of recognizing, searching, and finding are meant to be delegated to algorithms in order to synchronize the flood of information with the available capacities of perception. It is necessary to filter out patterns from the overflowing storage units in order to keep them intelligible.[593]

numbers (contributions of red, green and blue making its color). A computer has to use this ›low-level‹ information to try to guess what the image represents and how it represents it. […] Trying to ›close the semantic gap‹ […] is one of the motivations for using multiple features. For example, in the case of image analysis, a computer algorithm may extract various features from images, in addition to just the raw RGB values of the pixels. A computer can identify regions that have similar color value and measure orientations of lines and properties of texture in many parts of an image. The hope is that together all these features will contain enough information for an algorithm to identify what an image represents« (Lev Manovich, »Data Science and Digital Art History,« *International Journal for Digital Art History* 1 (June 2015), 13–35, here: 22).

593 For example, a research design like the »histoGraph« deals with large photo collections, promising to make it possible to explore the data of historical constellations of social networking contained within them: »[…] we have focused on a specific role of photographs as a source of knowledge aiding historical analysis of social ties and relationships. While photographs alone do not suffice to tell us about the exact nature of real-world social ties, they can be used to study the self-representation of historical entities to the public (e.g. politicians, state authorities, governments). On a micro level, image composition, gestures or objects can give insights into their self-understanding and the way in which they wanted the public to understand them. On a macro level, we can ask who was photographed often with whom, which constellations between actors, nations or positions occurred more often than others and how they changed over time« (Jasminko Novak et al., »HistoGraph — A Visualization Tool for Collaborative Analysis of Networks

Automated computation of stored image data reacts to their empirical proliferation and, as the continuous expansion of biometric identification technologies shows, is no longer a bureaucratic privilege, but has long since entered into the phase of normalization suited to the mass market: »What at first was developed and advanced by police forces, militaries, and secret services is now being used for purposes quite different from identifying criminals, monitoring the streets, and securing borders. Such technology has rather become an increasingly marketable aspect of consumer electronics: USB fingerprint readers are now used to secure access to sensitive data on laptops; Picasa, an image organizer owned by Google, allows users to browse through their private pictures with a face-recognition program; and game consoles equipped with 3-D cameras are able to distinguish between the various players standing in front of the television screen.«[594]

The image-based identification technologies used today in numerous applications of the Internet of Things stand in indirect continuity with the much older question of which operational tools are able to search through a photographic archive most efficiently. Even in the nineteenth century, Oliver Wendell Holmes's stereoscope collection was already conceived as a »comprehensive system of exchanges,« meant to facilitate search and consultation processes so that »all men can find the special forms they particularly desire to see as artists, or as scholars, or as mechanics, or in any other capacity.«[595] The construction of photographic finding aids consequently needed to create a conception of the spectrum of potential purposes for queries. As Michael C. Frank and Bernd Stiegler have noted, this gives rise to a desire—which was later prominently pursued in art-historical territory with Aby Warburg's mnemosyne project[596]—for »programs that search for similar images,«[597] which presupposes an idea of how iconographic similarities, kinship relations, shared patterns, motifs, and other categorial affiliations can be identified, formalized, and finally visualized in turn. In Alphonse Bertillon's police photo archive as well, the processes of cataloguing, as shown above, aimed at optimizing the addressability of the storage contents: »to invent a machine, or rather a clerical apparatus, a filing system, which allows the operator/researcher/editor to

from Historical Social Multimedia Collections,« *2014 18th International Conference on Information Visualisation (IV)*, Paris: IEEE, 2014, 241–250. doi: 10.1109/IV.2014.47).

594 Meyer, »Augmented Crowds,« 105.

595 Holmes, »The Stereoscope and the Stereograph,« 748.

596 Cf. Sabine Flach, Inge Münz-Koenen, Marianne Streisand (eds.), *Der Bilderatlas im Wechsel der Künste und Medien*, Paderborn: Fink, 2005.

597 Michael C. Frank, Bernd Stiegler, afterword to Oliver Wendell Holmes, *Spiegel mit Gedächtnis. Essays zur Fotografie*, ed. Michael C. Frank, Bernd Stiegler, Paderborn: Fink, 2011, 193–211, here: 209.

retrieve the individual instance from the huge quantity of images contained within the archive.«[598]

As Estelle Blaschke has illustrated with the history of the Bettman Archive, an independent media-historiographical narrative of photography arises if the point of departure is not apparatuses of image acquisition or aesthetic-stylistic conjunctures, but rather cultural technologies of managing and distributing photographs. Archiving images and making them searchable is closely linked to the value chains that can be extracted from storing photographs. The central problem from the viewpoint of an image agency is an ›archival noise‹ that becomes ever more impenetrable with the increasing size of the collection—which can be translated as a further inquiry into how transmittable and marketable signals can be filtered out from holdings whose stored contents, created as constitutively polysemic, carry with them a kind of internal information overload.

The fundamental ambiguity of visual content—up to and including the »punctum« that triggers idiosyncratic, intimate, ›digressive‹ readings, which, according to Roland Barthes, not only can be triggered by photographic temporal paradoxes, but also by marginal details that occur »in the field of the photographed thing«[599]—naturally creates limits for its rule-based, goal-oriented recognition. The »haze« that surrounds the visual objects is therefore older than the ubiquitous »numeric fields« implemented by media technology—and more fundamental than informational deficits of computation. Lukas Rosenthaler from the Imaging and Media Lab in Basel succinctly conveys this point as follows:

> I draw a fundamental distinction between image processing and image analysis. Image processing means: I have an image, change something algorithmically, and get an image again. Image analysis means: I have an image, apply an algorithm to the image, and end up with information that is no longer visual. Image analysis is much more difficult because the computer has no concept of image. […] For the computer an image is

598 Sekula, »The Body and the Archive,« 18.

599 Barthes, *Camera Lucida*, 47. In this vein, Estelle Blaschke writes: »[…] the photographic image has, paradoxically, proven to be quite resistant to indexing and retrieval, although it has widely shaped archival practices as an efficient medium of information storage. The polysemic nature of photographs and visual representations in general often hinders unambiguous classification, especially with regard to large collections and even more so for historical photography. The layer of time, or time distance, draws our eyes to marginal details in a photograph that we may not have noticed before: the way people, streets, clothes, hairstyles, advertising, or gestures looked in the past may draw our attention, as Roland Barthes famously noted when describing the ›punctum‹ and ›studium‹ of photography« (Blaschke, *Banking on Images*, 193).

> a pile of unordered numbers that state: at position X/Y I have brightness Z. This is not an image, but it is all that the computer sees. The problem is drawing conclusions from the image analysis about what could be in the image and what the difference from another image is. Image processing, image to image, is not entirely simple, but relatively simple. Image analysis, however, automatically extracting information from an image, is extremely difficult to program for the computer because we ourselves as human beings do not know how we process images.[600]

But even if the image search generally speaking abstains from analysis in this sense, the results can nonetheless be efficient. In the case of a popular reverse image search engine like TinEye[601] the image-based image search provides information, for instance, about addresses and variations of the empirical distribution of the image. Here, users do not input search terms, but upload image files in order to find out where this image appears, potentially in edited form, anywhere on the net—in a test case: after a comparison with 18.3 billion images in a processing time of 2.1 to 20.3 seconds [figs. 29/30/31]. As a general rule, the ›similar‹ images here are various processed versions of the same image. The actual ›identification‹ of an image does not occur through algorithmic recognition of content or objects—as is the case, in a simple form, for the Wolfram Language Image Identification Project, which attempts to give succinct answers to the question »What is this a picture of?«[602]—but only indirectly, namely, when the displayed URL locations contain contextual information in text form.

Ongoing debates about content-based image retrieval, or query by image content, revolve around the question of what exactly ought to constitute the image content that is to be automatically recognized and recoverable on demand. The necessary »re-semantification«[603] of a raster graphic remains a complicated undertaking. The calculable values that can be drawn directly from bitmaps relate first and foremost to the distribution of chrominance or

600 Quoted in: Rudolf Gschwind, Lukas Rosenthaler, Ute Holl, »Migration der Daten, Analyse der Bilder, persistente Archive,« Rudolf Gschwind and Lukas Rosenthaler in conversation with Ute Holl, *Zeitschrift für Medienwissenschaft* 2 (2010), 106.

601 See https://tineye.com.

602 See https://www.imageidentify.com (see also Stephen Wolfram's blog: blog.stephenwolfram.com). For a comparative test of current Computer Visions APIs (from Google, Microsoft, Amazon, IBM, among others) in terms of »image labeling capabilities« see goberoi.github.io, 17.04.2017 (see also Gaurav Oberoi, »Comparing the Top Five Computer Vision APIs,« Goberoi: Gaurav Oberoi's essays on technology and startups (blog), July 11, 2016, https://goberoi.com/comparing-the-top-five-computer-vision-apis-98e3e3d7c647).

603 Hubertus Kohle, *Digitale Bildwissenschaft*, Glückstadt: Verlag Werner Hülsbusch, 2013, 38.

luminance. At their core, the quantitative methods of moving image research that have recently re-entered discussions merely operationalize statistical agendas whose preliminary results themselves must become visual again via suitable data visualization processes in order to allow for extrapolation in terms of motif or style history.[604] But the notion that the infographics generated in this process can be more than occasionally interesting heuristic tools—Manovich here even believes in the discovery of a new »descriptive system« that overcomes linguistic limitations in image access[605]—remains rather questionable, even beyond the quasi-DH formats circulating on social media such as moviebarcode,[606] for instance in view of more complex modes of visualization such as Kevin L. Ferguson's *Volumetric Cinema*, a project that translates image sequences into »tomographic« visual bodies.[607]

Non-text-based procedures of image searching, such as those tested in the art history wing of digital humanities, do attempt to replace conventional

604 For a media history of statistical processes of analyzing film styles, which seek to extract historically differentiated work data profiles from visual patterns—from Barry Salt's Average Shot Lengths (ASL) to the Cinemetrics Project of Yuri Tsivian and Gunar Cijvans—cf. Christian Gosvig Olesen, »Towards a ›Humanistic Cinemetrics‹?,« in: Karin van Es, Mirko Tobias Schäfer (eds.), *The Datafied Society: Studying Culture through Data*, Amsterdam: Amsterdam University Press, 2017, 39–54. On the current state of digital humanities in issues related to the moving image, cf. Acland, Hoyt, *The Arclight Guidebook*.

605 Manovich, »How to Compare One Million Images?,« 263. See also Manovich, »100 Billion Data Rows a Second: Culture Industry and Media Analytics in the Early 21st Century,« *International Journal of Communication* 12 (2018), 473–488.

606 See https://moviebarcode.tumblr.com.

607 Kevin L. Ferguson presented his project in a video essay (https://vimeo.com/119790662)—in the video description we read: »I use public domain software, primarily ImageJ imagej.nih.gov/ij/, to analyze film frames and reconstitute film scenes in novel ways. ImageJ was developed for and is primarily used in medical applications such as hematology, radiology, and the analysis of computed axial tomography (CAT) or positron emission tomography (PET) scans. Taking these last two examples, in layman's terms tomography means imagining a series of two-dimensional ›slices‹ of a three-dimensional volume, which can later be stacked back together and manipulated with a computer. This is useful for imaging biological structures inside the human body that otherwise remain invisible. My research begins similarly by treating films as tomograms, using ImageJ's tools to manipulate film scenes as three-dimensional volumes and to measure (and manipulate) a scene's color and brightness values. The result is a new kind of digital film forensics not bound to the two-dimensional slice of the film projector, but which can access and interpolate an infinite number of new volumetric slices for digital projection. My video demonstrates four increasingly complex ways that the dimension of time in moving images can be visualized: the slit-scan, the barcode, the slice and orthoslice, and the cube« (cf. also: Kevin L. Ferguson, »The Slices of Cinema: Digital Surrealism as Research Strategy,« in: Charles R. Acland, Eric Hoyt (eds.), *The Arclight Guidebook to Media History and the Digital Humanities*, Sussex: Reframe Book, 2016, 270–299).

indexing with visual search models, but they often fall into positivistic traps of having to reduce ›contents‹ to parameters like quantifiable color components: »We are therefore left with [...] only a classification according to similarity, a pre-rationalist category. Similarity is then expressed as a statistic indicating the distance between the requested picture-characteristic and potential matches. What is measured are color components in the image, forms, and patterns.«[608] Because the »number of isolable image-signifiers [...] is perhaps infinite« and »visual encyclopedias with isolable image-atoms«[609] can thus, at best, be implemented as projects of user-annotated motif comparison applicable to a limited body of art historical images,[610] the most recent expectations have increasingly been directed toward the progress being made, with varying degrees of success, in processes of image recognition and image classification that employ learning algorithms, which ›train independently‹ using example data—such as the data set of the ImageNet Project,[611] which has established itself as the competitive standard of machine learning.

In this context, image captioning models[612] have recently been relatively successful, models whose output—for instance in the form of automatic tagging—additionally seem to be comparatively compatible with cultural practices that search and organize images according to semantic registers.

608 Warnke, »Bildersuche,« 32, 34. Similar image searches in this sense are offered, for example, by the Munich Digitization Center (MDZ), whose website reads: »The only criterion is the similarity of motifs based on characteristics such as colors, textures, shapes and contrasts« (https://bildsuche.digitale-sammlungen.de/index.html?c=projekt&l=en). At Yale University there is a project applied to the digitized photographs of the Meserve Kunhardt Collection; this project's image similarity algorithm is based on the classification processes of approximate nearest neighbors and the training dynamics of Convolution Neural Networks (cf. https://dhlab.yale.edu/neural-neighbors).

609 Ibid., 36.

610 On the image annotation tool HyperImage at the prometheus image archive (prometheus-bildarchiv.de), cf. Lisa Dieckmann, Anita Kielmann, Martin Warnke, »Meta-Image—Forschungsumgebung für den Bilddiskurs in der Kunstgeschichte,« *cms-journal* 35 (2012): 11–17, DOI: 10.18452/6626.

611 On the history of the ImageNet Challenge and the significance of its data set, which by now encompasses 13 million sample images, cf. Gershgorn, »It's not about the Algorithm.« On video images as training data, cf. the works of the Berlin startup TwentyBN, whose data set consists of over 250,000 labeled videos and aims for machine learning of »visual common sense« (Moritz Müller-Freitag, »Learning about the World through Video,« *Medium*, June 21, 2017, https://medium.com/twentybn/learning-about-the-world-through-video-4db73785ac02; the corresponding research article can be found here: Müller-Freitag et al., »The ›something something‹ Video Database for Learning and Evaluating Visual Common Sense,« June 15, 2017, https://arxiv.org/abs/1706.04261; cf. also Andreas Sudmann, »Das intuitive Wissen der Maschinen,« *Neue Zürcher Zeitung*, October 27, 2017).

612 Cf. https://github.com/karpathy/neuraltalk2.

Here, algorithmic visual reading leads to automatically generated image captions, and thus again aims at words or networks of words that can be searched and enable an image to be classified and found. The situation is different with recent developments in the field of automatic facial recognition, which also rely on »unsupervised learning« and thus, according to Felix Stalder, obtain significantly improved results:

> From around ten million individual images randomly selected from YouTube videos, analyzed in a cluster of 1,000 computers with 16,000 processors, it was possible in only three days to create a model that improved facial recognition in unstructured images by seventy per cent. The algorithm of course does not ›know‹ what a face is, but it can reliably recognize a class of forms that human beings identify as a face. One advantage of a model that is not created on the basis of predetermined parameters is, for instance, that it can also identify faces in non-standardized situations (for example if a person is located in the background, if the face is half obscured, or if it was photographed from a sharp angle). Thanks to this technology we can search directly for image contents and not, as has primarily been the case until now, for image captions.[613]

However, relatively simple crosschecks such as the classification of negative images (entirely unproblematic for human agents), still produce rather uninspiring results.[614] But from the viewpoint of human perceptual routines, what an image contains, what it represents or symbolizes, what it refers to, how iconic and indexical components flow into the aesthetic process of perceiving ›something‹ (as something), will only be able to be simulated algorithmically in reductionist form, even in the future. Even if the effort to classify and identify objects represented in an image has by now achieved error rates under 2%, in the case of the ImageNet database, when it comes to more demanding tasks, it is still the case that: »This doesn't mean an algorithm knows the properties of that object, where it comes from, what it's used for, who made it, or how it interacts with its surroundings. In short, it doesn't actually understand

613 Stalder, *Kultur der Digitalität*, 180.

614 Such as those from a recent research report on deep learning image recognition: »[…] we test the state-of-the-art DNNs with negative images and show that the accuracy drops to the level of random classification. This leads us to the conjecture that the DNNs, which are merely trained on raw data, do not recognize the semantics of the objects, but rather memorize the inputs« (Hossein Hosseini, Radha Poovendran, »Deep Neural Networks Do Not Recognize Negative Images,« in: https://labs.ece.uw.edu/nsl/papers/hossein_2017.pdf).

what it's seeing. [...] While our AI today is fantastic at knowing what things are, understanding these objects in the context of the world is next. How AI researchers will get there is still unclear.«[615]

Nevertheless, a delegation of agency that operationally links cultural technologies of the image to computers has long since been taking place on a variety of levels. This can be seen in digital daily life, for example in conventional processes of facial recognition, which presort collections in photo applications, or in smart security camera systems like Netatmo (»able to detect people, cars or animals«[616]), which compute the selected image data in terms of authorized access—a model of ›intelligent‹ processing of environments captured by image technology that the next chapter will consider in more detail.

Image-related algorithms are currently establishing a lasting position for themselves particularly in the distribution of images within the economy of visibility in toto, which is regulated by the page rankings of commercial search engines and recommendation systems. The digital stream of images is permeated by filter technologies that curate and hierarchize visual culture and personalize it as a feed. Functionally this is a matter of image filters that interrupt distribution instrumentally, censor the flow, and direct it into preformatted channels. A quintessential example of algorithms trained in image readings whose recognition capacity as a distribution barrier is again programmed on the basis of ›standardized situations,‹ would be applications of computer vision-based pornography filtering (CVPF). Tasked with distinguishing non-pornographic from pornographic images—for instance, in the context of parents concerned for their children's media consumption, to allow only the former to appear on their screens—the problem of the signal-to-noise ratio is manifest specifically in the realm of machine learning.[617] As Robert Gehl, Lucas Moyer-Horner, and Sara K. Yeo have shown, even before the implementation of filters trained with learning algorithms, heteronormative »gender scripts« at work in human conventions of perception come into play, concretely influencing what computers ›see‹ insofar as they preselect example data that trains the pattern extraction in the first place:

> Indeed, our analysis of CVPF shows that the computer scientists who train computers to see and filter online pornography are inscribing assumptions about pornography, human sexuality, and bodies into their academic field: namely, that pornography is limited to images of naked

615 Gershgorn, »It's not about the Algorithm.«
616 https://www.netatmo.com.
617 See also footnote 158.

> women; that sexuality is largely comprised of men looking at naked women; and that pornographic bodies comport to specific, predictable shapes, textures, and sizes. In other words, judging from their published works and conference articles, computer scientists appear to be training computers to see the narrow form of pornography described above while dismissing a heterogeneous array of other forms of pornography (gay, queer, trans*, hardcore, fat, bondage, hairy, and so much more) as ›noise.‹[618]

As an example of the transfer of gender bias,[619] CVPFs point to a relatively fundamental problematic of algorithmic filters—these filters can be permeated on a variety of levels by the biased structures of human perceptual activities, which are in turn objectivized and perpetuated by information technology.

In the field of algorithmic image content recognition, we can also now observe counter-dynamics inasmuch as technological advances are being confronted with competitive disturbance programs meant to complicate or block readability. One example here would be »image-agnostic perturbation vectors,« whose application allows for image output to remain unchanged from the viewpoint of human perception, while profoundly disturbing classification by processes of machine learning and resulting in constantly erroneous identifications.[620] However, as mentioned above, non-human, automated image storage readings do not begin with object recognition processes themselves, but are already in effect in the display of search engine results. On this level, the distribution of the archive is the product of an increasingly personalized economy of visibility, which sorts through the storage in a way that is specific to the request, in view of a dynamically generated creation of order: »The algorithm no longer primarily determines what is relevant through the position of a document within an informational world that is dynamic but still exists externally for everyone. […] A different arrangement is generated for each person, and it is no longer simply a selection of a previously existing order

618 Robert Gehl, Lucas Moyer-Horner, and Sara K. Yeo, »Training Computers to See Internet Pornography: Gender and Sexual Discrimination in Computer Vision Science,« *Television and New Media* 18/6 (September 2017), 529–547, here: 530.

619 One research group working on neutralization strategies came to similar results: Jieyu Zhao et al., »Men Also Like Shopping: Reducing Gender Bias Amplification Using Corpus-level Constraints,« July 29, 2017, https://arxiv.org/abs/1707.09457. Cf. also: Megan Garcia, »How to Keep Your AI from Turning into a Racist Monster,« *WIRED*, February 13, 2017, https://www.wired.com/2017/02/keep-ai-turning-racist-monster/.

620 Cf. Seyed-Mohsen Moosavi-Dezfooli, Alhussein Fawzi, Omar Fawzi, Pascal Frossard, »Universal Adversarial Perturbations,« November 17, 2016, https://arxiv.org/abs/1610.08401.

that is displayed.«[621] Insofar as the positioning of a document does not mark a ›neutral‹ and thus reproducible location, but generates or suggests constantly divergent meaning through relative proximities and contexts, an application like Google Images carries out an automatic storage computation that at least prestructures individual storage readings, in many cases simply by sorting and evaluating the images.

Digital archives such as that of the USHMM, as explained above, feed their material to the dominant informational processes and logics of the visual economy, on the one hand, while on the other hand also attempting to establish reliable accessibility for valid reference locations, which are based on traditional archival standards of managing and reading storage. As digital reproductions, the visual documents of the Holocaust become more fungible and more compatible in various directions. Nonetheless, the capacity of historical sources to be sorted using applications such as TinEye and the Wolfram Language Image Identification Project—the »hermeneutic scope«[622] of the transformed ›understanding of the image‹—is limited. During test runs, TinEye delivered indications of distributive ranges and histories of distribution and modification; for what is probably the most iconic Auschwitz image, the Image Identification Project recognizes neither a unique historical location nor railway tracks, but merely a »tower« [fig. 32], while one of the four photographs (strictly speaking: an enlarged section) taken in August 1944 by an anonymous member of the special commando near Crematorium V in Birkenau, is classified as »flowering cherry« [fig. 33]. Renowned providers like Clarifai[623] do not fare much better. The programming interface recognizes »people« where there are none (but at least identifies a »transportation system« and »war«) [fig. 34] and in another case suggests »no person« and »art« [fig. 35]. Even where the signals are unambiguous in the sense of a globalized memory culture, even ›iconic,‹ and thus it is not a matter of subtly examining evidence in a historiographic-investigative mode, the computer only ›sees‹ archival noise and a haze of numbers.

621 Stalder, *Kultur der Digitalität*, 189–190.

622 Wettlaufer, »Neue Erkenntnisse durch digitalisierte Geschichtswissenschaft(en)?«

623 Cf. https://www.clarifai.com (on the comparatively high estimate of success, see also: Ralph Windsor, »Clarifai vs Google Vision: Two Visual Recognition APIs Compared,« Digital Asset Management News, August 12, 2016, https://digitalassetmanagementnews.org/emerging-dam-technologies/clarifai-vs-google-vision-two-visual-recognition-apis-compared/).

With regard to those »images in spite of all,« whose interpretation is extremely contested even in the absence of algorithmic access,[624] this example test of recognition might come across as polemical—but it does show that automated image content recognition will remain a limited field of activity for the long term, at least as a prerequisite for historiographic source studies. Even digital humanities tools that can be implemented with little effort technologically—which Lev Manovich attempted to profile using the umbrella term »cultural analytics«: »visualising images in a scatter plot form according to quantitative descriptions of their visual properties measured with digital image processing techniques«[625]—essentially generate visualization technologies of image distribution escalated by social media that are based on statistical value surveys,[626] but with any projects that are heuristically somewhat more demanding, they already run up against translation limits, which Martin Warnke has extrapolated in terms of media theory:

> The image burdens every searcher not just with its two dimensions. It also possesses such an immense variety that a computed visual similarity does not produce any satisfying results. It is obviously not only dependent on the fact that in the computer both text and image are actually numbers—represented in binary code—and therefore all media types can be equally subjected to the same algorithms. In number, text, and image we are dealing with three basic media that can indeed be converted into one another in terms of the code, but not in terms of the cultural practice, which of course includes their indexing.[627]

Productive operational translations between »image, text, and number«[628] are nonetheless possible within limits, as demonstrated by the comparatively low-threshold approach of the Public Access Digital Media Archive.[629] The non-commercial collection of digital videos is able to be sorted not just by color and brightness distribution, pixel density, frequency of cuts, and similarly invasive calculations. On the textual basis, culturally speaking, of digital subtitling formats, the archived videos can also be searched for transcribed

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624 Cf. Didi-Huberman, *Images in Spite of All*, 173ff.
625 Manovich, »How to Compare One Million Images?,« 263.
626 Cf. Lev Manovich, *Instagram and Contemporary Image* (self-pub., 2017), available at http://manovich.net/index.php/projects/instagram-and-contemporary-image.
627 Warnke, »Bildersuche,« 33f.
628 Cf. also Sybille Krämer, Horst Bredekamp (eds.), *Bild — Schrift — Zahl*, Paderborn: Fink, 2008.
629 See https://pad.ma.

word usage, which—setting aside oral utterances that are not transcribed or transcribed incorrectly—comes relatively close to the idea of a full text index on the level of language content. The image sequences are thus computed via textual intervention: in a simple (but effective) text-based ›distant reading,‹ the film history stored at the Pad.ma archive can, for instance, filter out and reproduce all sequences in which someone says the sentence »get out of the car«[630] or, hypothetically and more relevant to the topic of this chapter, »I was only obeying orders.« The output for the first phrase offers a series in which numerous women are being pulled out of a car by gruff men, or humorless policemen are expressly unsatisfied with documents provided. The latter, applied to the SHOAH outtakes at the USHMM—for which, unlike the VHA videos, complete transcriptions are already available as text image pages in PDF format—would filter all the encounters with Nazi perpetrators from the holdings and provide paradigmatic citations to demonstrate an argumentative strategy of shifting blame, notoriously popular in these circles. From the viewpoint of an audiovisual source study supplied with a wealth of material, even mentioning locations, persons, etc., by means of this heuristic process of »applying computing power to historical documents«[631] would potentially turn out to be more productive than the thoroughly vague visualization, still widely discussed in the context of Digital Humanities, of »›latent stylistic patterns‹ of colour, sound and movement.«[632]

The fact that the USHMM is quite interested in epistemologically ambitious, more invasive digital tools of archival evaluation and heuristics—that is, it does not insist on a fundamental primacy of ›analog‹ processing and classical ›hermeneutic‹ interpretation—is demonstrated by a research project that started in 2007 under the title »Geographies of the Holocaust,« which sought to use data-based processes of geovisualization to explore the scope of a »spatial turn« in Holocaust research.[633]

The approach of algorithmically processing geographical information that is related, for instance, to the system of concentration and

630 I am grateful to Sebastian Lütgert for pointing out this example. Lütgert is the founder and programmer of Pad.ma and presented the software at a workshop of the DFG project »Streaming History« at the Ruhr University in Bochum, Germany, in the winter semester of 2015/16.

631 Putnam, »The Transnational and Text-Searchable,« 400.

632 Olesen, »Towards a ›Humanistic Cinemetrics‹?,« 50.

633 Cf. Anne Kelly Knowles, Tim Cole, Alberto Giordano (eds.), *Geographies of the Holocaust*, Bloomington: Indiana University Press, 2014.

extermination camps,[634] death marches,[635] the mass murders carried out by the *Einsatzgruppen*,[636] or to the creation of Jewish ghettos[637]—in short, this is a matter of translating spatially oriented historical information into dynamic cartographic representations, virtually modelled environments, and other interactive modes of visualization used in Geographical Information Science (GIS)—conceives of the extensive collection of digitized texts and image documents at the USHMM Archive as database material from which patterns are to be extracted through quantitative analyses: »[…] spatial analysis and geovisualization can complement and help specify the humanistic understanding of space and place by exploring and quantifying relationships among things and people to discover and visualize spatial patterns of activity.«[638]

We can speak here of an overarching »Visualization of the Archive«[639] inasmuch as the output of this approach—in which visual sources like photographs, diagrams, and maps, input neglected by mainstream historical scholarship, play an eminently important role—itself relies in turn on the visual clarity of modes of data visualization, which in this case is also associated with the specific big-data promise of transparency and intelligibility, as Tim Cole has acknowledged: »You clearly see something through visualizing that you don't see in the archive.«[640]

When Claudio Fogu, discussing the »beautiful data« that is distributed in this way (Orit Halpern), speaks of an underlying »iconophilia« in GIS and refers to fundamental problems of the concomitant effects of aestheticization,[641] he

634 Anne Kelly Knowles, Paul B. Jaskot et al., »Mapping the SS Concentration Camps,« in: ibid., 18–51.

635 Simone Gigliotti, Marc J. Masurovsky, Erik B. Steiner, »From the Camp to the Road: Representing the Evacuations from Auschwitz, January 1945,« in: ibid., 192–226.

636 Waitman Wade Beorn, Anne Kelly Knowles, »Killing on the Ground and in the Mind: The Spatialities of Genocide in the East,« in: ibid., 88–119.

637 Tim Cole, Alberto Giordano, »Bringing the Ghetto to the Jew: Spatialities of Ghettoization in Budapest,« in: ibid., 120–157.

638 Anne Kelly Knowles, Tim Cole, Alberto Giordano, »Geographies of the Holocaust,« in: ibid., 1–17, here: 15.

639 Paul B. Jaskot, Anne Kelly Knowles et al., »Visualizing the Archive: Building at Auschwitz as a Geographic Problem,« in: ibid., 158–191.

640 Claudio Fogu, Todd Presner, »Interview with Anne Knowles, Tim Cole, Alberto Giordano, and Paul B. Jaskot, Contributing Authors of *Geographies of the Holocaust*,« in: Fogu, Presner, Wulf Kansteiner (eds.), *Probing the Ethics of Holocaust Culture*, Cambridge, MA: Harvard University Press, 2016, 240–256, here: 243.

641 Claudio Fogu, »A ›Spatial Turn‹ in Holocaust Studies,« in: ibid., 218–239, here: 234. Fogu's critique of the project is ultimately directed toward its access to the dimension of historical experience: »What we find [here] is *in nuce* the schizophrenic movement of GoH's [Geographies of the Holocaust] iconophilia caught between repeated and ever-emptier

surely hits on a sensitive issue. It has not gone unnoticed, at least among the project participants, that due to the origin of the documents, which should always be critically considered on a meta-historiographic level—and in this context, with very few exceptions, concerns precisely the photographic and film sources of the Nazi period—there is also the danger of reproducing the »totalizing gaze« of the historical perpetrators in the presumption of transparency and clarity of data visualization: »[…] we see the act of mapping as, in part, critical engagement with the world envisioned by the perpetrators.«[642] The GIS data images are fundamentally digital interpretations, mediated by software, of an archive that is operatively interpreted already in the course of compiling the database—the archive is datafied selectively, in a way that is driven by specific interests, if only because the potentially informative contents of an archival photograph can neither be exhaustively indexed (as mentioned above in discussing the keywording of the Visual History Archive of the Shoah Foundation) nor quantified without some loss.

How exactly geographical information was extracted from the archival image materials, what was quantifiable and what was not, also remains underdetermined to a certain degree in the example applications of the Geographies of the Holocaust project. In this context, one sub-project becomes comparatively concrete as it calculates Auschwitz-Birkenau as a 3D model primarily on the basis of documents from Central Construction Management. In order to empirically compare the construction plans with the historical intermediate states and conditions of their implementation, however, they also draw on selected photographs: »[…] a vast body of evidence reveals how the organization and uses of space at Auschwitz diverged from the 1943 plan. Significant portions of the evidence are visual. For example, photographs taken of the arrival of Hungarian Jews in 1944 show awkward juxtapositions of peoples and structures, mud-filled spaces, and unruly groups of figures that belie the order and visual unity of the plans […].«[643]

One application that goes beyond topographical facticities is aimed at the perpetrator's gaze, which is already problematized in the context of archive-critical questions; this gaze is formatted via a digital model of historical viewing ranges and fields of vision. The visibility of the archive, distributed by

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declarations of being grounded in ›objective geography‹ or, more generally, ›empiricism,‹ and a much more powerful yearning for the sensory appeal of presence, that is, for gaining access to ›experience‹« (ibid.).

642 Knowles, Cole, Giordano, »Geographies of the Holocaust,« 9.

643 Jaskot, Knowles, et al., »Visualizing the Archive,« 160.

means of visual archival materials, is meant to generate an empirically robust »view-shed analysis«:

> We developed the idea much more fully in this project, by assigning structural dimensions to the barracks, crematoria, and other key features in Auschwitz-Birkenau, which was possible based on the detail of the archival evidence. This procedure gave us our quasi-three-dimensional model for the main parts of the camp. Because the structural dimensions were entered as numerical measurements in the model, we could also use visualization techniques to approximate fields of view from key locations, such as the ramp where prisoners were off-loaded from train cars. […] One could use the three-dimensional digital model to investigate the particular avenues or areas visible to any individual, whether an SS guard or an inmate.[644]

The general guiding thesis of this »spatial turn« applied to the genocidal spatial policies of the National Socialists—»that the Holocaust was implemented through space and not merely in space«[645]—is broken down here to the microhistorical perspective of the digitally reconstructed fields of vision of individual agents. What is thereby visualized in the data as a pattern is a distribution of visibility in historical space derived from power relations. In a certain sense, the modelling of this distribution goes beyond the visual information of the archive, as the project participants maintain: »Using geographical and art historical tools also enabled us to discern spatial patterns of relative power and to intuit visual experiences that are not recorded in any document or captured in any historical photograph.«[646]

In practice, such recalculations of digitized archival information are no longer being used only in the context of speculative Digital Humanities projects, but also in the crime scene forensics that support real law enforcement agencies. For instance, the geomedia technicians of the highly specialized photo department at the Bavarian State Office of Criminal Investigation, commissioned by the Weiden Prosecutors Office, recently also created a virtual 3D model of Auschwitz-Birkenau [figs. 36, 37, 38, 39, 40] in order to reconstruct possible points of view of the SS guard Johann Breyer, who, following the

644 Ibid., 184–185.

645 Paul B. Jaskot, Tim Cole, afterword to Anne Kelly Knowles, Tim Cole, Alberto Giordano (eds.), *Geographies of the Holocaust*, Bloomington: Indiana University Press, 2014, 227–232, here: 228.

646 Jaskot, Knowles et al., »Visualizing the Archive,« 187.

Demjanjuk verdict, was supposed to stand trial in 2016 for aiding and abetting 200,000 murders. Breyer died, however, immediately before the proceedings began. Nevertheless, the computer graphic model, already produced with great effort[647]—based on 3D laser measurements on site, with which extant barracks, guard towers, and building remains were digitally scanned, and on maps from the Polish land surveying office, aerial photographs and archival photographs, from which the geomedia technicians were able to extract details such as the spatial arrangement of rows of trees[648]—was used in a similar trial against the SS *Unterscharführer* Reinhold Hanning, who was also active at Auschwitz-Birkenau on guard duty, if not more. He claimed not to have seen the extermination camps' crematoria from his guard tower, but this was rejected as implausible in the opinion of the Detmold court with explicit reference to the visual range calculated in the virtual model. A forensic practice of algorithmic visualization of the archive operationalized in this way therefore is not aimed merely at sorting capacity, but aggregates distributed information—including especially information that has been extracted from image documents—in order to extrapolate evidence that is only intelligible when is it played out visually.

The use of invasive tools—»as access not only *to*, but *in* the documents themselves«[649]—can, as this example suggests, develop a specific heuristic productivity in which information contained in the archive images is calculated with various other data in order to redistribute visibility. If archival images are quantified and computed here in terms of their data visualization in the form of virtually navigable models, empirically speaking they often remain relatively intact in most digital archival contexts: as informative objects which cultural practices draw on, whose visual forms—not simply »transferable« (Martin Warnke), but distributed in multiple ways—can be read and explored in terms of (media) historiography.

The datafication of distributed archival images unquestionably leads to more invasive modes of distribution and computation. However, the output

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647 The crime scene forensic approach of a video installation by Forensic Architecture screened at documenta 14 (*77sqm_9:26min*, 2017) works in a quite comparable way. Here, the NSU murder of Halit Yozgat in a Kassel internet café is reconstructed and virtually simulated in terms of the field of vision of Andreas Temme, a member of the Federal Office for the Protection of the Constitution who was present at the scene of the crime. The work was presented on August 25, 2017, at the Hessian NSU Investigation Committee (cf. Matthias Dell, »V-Mann Temme in der ›Mausefalle,‹« *Der Freitag*, August 30, 2017; on Forensic Architecture cf. footnotes 50, 51 in the introduction).

648 Cf. Martin Bernstein, »3-D-Modell von Auschwitz soll NS-Verbrecher überführen,« *Süddeutsche Zeitung*, August 29, 2016.

649 Ernst, »Zwischen(-)Speichern,« 104.

of this processing—albeit contingent—often continues to be guided by the playing out of visual data surfaces. Despite being distributed, digital images still often circulate ›as images‹—and thus as something whose phenomenality human perceptual activity can relate to directly. By contrast, the following section (III), which concludes this study, will address the question of what aspects of (or which) iconicity resists, what must be considered when the information-technological media logistics of distributing, datafying, and storing digital images is not following an agenda of streaming archives, but instead migrates into the surrounding environments.

III

In the Ambience
Sensor Networks

The distributed image can be understood as a symptom of the advance of datafication, but also as its driving force. More and more images contain more and more information, insofar as their distribution itself produces data, namely by generating transport traces that can, in principle, be calculated in ›real time.‹ The datafication involved in distribution takes place via sedimentations based in storage technology, in which patterns can be recognized. The question of what is significant in the data of digital images is thus not limited to an isolated image code, to the level of making and editing images, but fundamentally must include distribution parameters, the versatile traffic form of these images. Even without the empirically obvious excessive aftercurrent of constant newly acquired visual data—in the sense of an initial visual capture—the emergence of image-related data traffic would not stagnate as long as the status quo of image storage holdings continues to circulate. It is precisely this continual creation and accumulation of ever new distribution information that currently surrounds the digital image with ›big data.‹

From this perspective, the increasing storage of image metadata comes ever closer to the ›actual‹ image data, the pixel values—the »pile of unordered numbers that state: at position X/Y I have brightness Z« (Rosenthaler)—allowing for conclusions to be drawn about circulation histories, but also altering future accessibility and thus a constitutive element of the logistical state of the distributed image. This image is first transformed not in contexts of social media usage, in practices of explicitly manipulative editing and conditions of visible mutation, but fundamentally through distribution itself, that is, even when from the viewpoint of a human user the visual surface appears untouched, self-identical.

It is not just that the stream—its volumes, the concrete information-technological reification of its computer-network-based connecting operations—is always channeled differently. The image transported through this stream, which has generally speaking become trackable in real time, is likewise not truly stable, but adaptively modulated, and thus continually adapting to registered datasets and infrastructural circumstances: by taking account of the available connection qualities, geolocational markings, accumulated tracking and profile data of the clients sending server requests, to the variable technological-situative capacity of the end devices waiting on the horizon of these operations. The distributed image comes into existence in relation to such calculated feedback loops, which constantly create more data that require processing and are effectively not distinct from the image, but part of it, continually expanding the information it comprises.

As was shown in the last chapter in connection with photographic and videographic prehistories of technological image distribution, this dynamic continually works its way deeper into historical image archives, whose status, once exclusively analog, was still associated with reservations about distribution and other conceptions grounded in repositories. The agenda of successively expanded retro-conversion gives rise to a logistical bifurcation that joins the newly generated digital reproductions to the format standards and transfer protocols of the dominant data traffic model and pragmatically renders the original material increasingly inaccessible as it falls behind and is stored peripherally. Visual material that has been made newly distributable through digital transfer archives can nonetheless be interrogated for the signals of its distribution history inscribed within it, and thereby interpreted in terms of media historiography, which then leads, for instance, to the technological genealogies of discretization outlined above or to transitions between analog and digital modes of transmission. The multifaceted histories in which these images are entangled are not least the histories of their transcription and distribution.

From this perspective, what nonetheless seems to remain relatively stable—despite all the logistical dynamics and material restructurings, despite new archival circuits and visualizations, despite modified ranges and the emergence of automated or ›distanced‹ modes of reading—is the reference to the image *as image*. Retro-converted forensic photographs from the 1910s, like digitized 16mm film material (which, in the example discussed above, technologically consolidates the act of transmitting a video signal as an image of a monitor), can only be discussed to a limited degree, at least from the media-historiographic perspective suggested here, without recourse to information that precisely does not materialize (only) as code. Consideration of the profoundly datafied nature of digital images does not resolve the question of their status as image. It is therefore still necessary to consider what it means that certain data carry with them images that, as in the cases examined here, informatively translate photographic and film connections.

The histories that these images distribute also include the histories that they have stored visually and are able to translate as images. What (and how) an image shows (something) still counts for something here—even if, from the perspective of media technology, there are only abstract values being processed as raster graphics. In other words: although the digital reproductions are streaming phenomena that can be mobilized for purposes of archival transmission, are digital series of datagrams, the information that these images contain still includes what recipients are accustomed to drawing from visual image surfaces. How exactly this reading process takes place as a cultural practice is itself ›in motion.‹ Distributed images thus generally operate in certain social media contexts as a communicative abbreviation that must also be ›read‹ in a different way by the addressees, for instance with an awareness of viral careers. Conversely, however, we should also observe here that the communicative compression of visuality is increasingly being supplanted by expansive processes of quasi-omnidirectional, open-ended recording and distribution, as is suggested by the growing popularity of social media video applications with functions for instantaneous live streaming. The image here becomes a potentially endless feed of continuously streaming data.

With respect to digitally distributed archival images like those just examined, under these conditions the concern is, on the one hand, with expanding analyses of these images to include the digital information they contain beyond their visually convertible data set components. On the other hand, however, without taking into account the potential of visuality associated with this data, a potential that can be realized via various media-technological agencies, access would still remain limited. The cost of omitting the visual ›exterior‹ of the data is that there can be no discussion of an empirical ›surface‹ reality in such data objects. Streaming images seem to enter the sea of big data calculable by information technology not entirely as undifferentiated bit strings, at least insofar as digital image practices are based on the fact that the information operationalized in this process is specifically formatted and displayable data. If the distributed image persists *as an image*, then this is also because it is coupled with cultural technologies, with practices of the image that are older than today's networks of its digital datafication.

But it need not remain so. In the field of recent developments in imagine technology, which the two concluding chapters are devoted to for the sake of expanding the study's outlook, this constellation of a data image being disseminated through digital transmission channels—which is still an ›image‹ to the extent that it appears impossible to conceptualize without recourse to the data exterior of materialized visuality and the practices related to such visuality—increasingly unravels. And this directly on the level of output, to which the persistence of its effectiveness is due: to the phenomenalized image as a visual form and operational interface. More and more often we are no longer dealing with images that contain information, but with information that was captured via optical systems, but is only secondarily, if at all, geared toward the display of image forms. The image, its iconic phenomenality, no longer appears here only as a contingent visualization of data that can be manipulated at the level of pixels and mobilized in versatile ways, but as a visualization that in purely functional terms, from the perspective of the defining instrumental methods of processing such image data, need not be realized. This gives rise to a kind of paradox, which initially leads to new media-technological processes and operationally reconfigured ›sites‹ of capturing images, and in the final analysis to the emerging field of ›smart‹ sensors and environments. The more advanced, computation-based, and algorithmic digital imaging technologies become, the more deeply they become embedded in multimodal sensor networks, the less ›image‹ they contain.

This speaks to a tendency in which the ubiquity of the distributed image in the visual culture of the present, as described at the beginning of this study—a ubiquity substantially fostered by smart phones and social media—takes on a different quality, reorienting itself away from a ubiquitous distributability that is merely *everywhere* toward technological arrangements that have been discussed for a few years now with the catchword *everyware*.[650] As the next chapter will outline with respect to image-technological aspects of the media studies discussion surrounding topoi like »ambient intelligence,« »smart environments,« or »ubiquitous computing,« the consequence is that agendas of visual capture in these cases are increasingly located beyond data visualization in image form. We must therefore consider the implications for image theory of a media constellation in which, as quoted in the second chapter, »the transfer of data beyond their contents becomes the permanent condition of our surroundings.«[651]

Technological processes of visual data collection continue to be increasingly sophisticated in the context of sensor networks, but are often only secondarily geared toward translating conventional image forms that are ›photographically‹ readable in the broadest sense as their final media product—as products that are more or less immediately clear as images *of something*, and this precisely not in an primarily »systemic« sense, as Inge Hinterwaldner has described the specific iconicity of computer-based simulation imagery.[652] The fact that the boundaries here are becoming increasingly permeable, that a typology of contemporary data imagery does not suggest a categorial (or even ontological) distinction between computer-based modes of visualization, augmentation, and viewing, but rather an operational distinction, will also be discussed further below.

Automatisms of algorithmic data processing, which result in complex data fusion according to diversification of the input, generally process optically recorded and visually implementable environmental data without iconic

650 Cf. Greenfield, *Everyware*, and Kember, »Ambient Intelligent Photography.«
651 Engemann, Sprenger, »Im Netz der Dinge. Zur Einleitung,« 28.
652 Hinterwaldner, *Das systemische Bild*.

interludes. Image sensors capable of computation proliferate, are integrated in miniaturized form in more and more technological objects and networks, while graphic data visualization itself in a certain sense becomes »calm,«[653] retreating into the background. In closing, we will consider this process of a phenomenally dissolving, instrumentally dispensable final image product (or even just intermediate image product) of visual capture, which migrates into the ambience and, while it remains quite effective there, is integrated in ›imageless‹ processes of datafication and calculation. The discussion, proceeding in two steps, interrogates methods of capturing image data with sensors and the operative status of the acquired data images: first on the level of the processes of visual capture modified by media technology, which is reorganized as distributed acquisition in sensor networks and thus becomes ›ambient‹ (III.1); and second, in view of an image that is logistically redistributed and ›calmed‹ (III.2).

653 Mark Weiser, John Seely Brown, »Das kommende Zeitalter der Calm Technology,« in: Christoph Engemann, Florian Sprenger (eds.), *Das Internet der Dinge. Über smarte Objekte, intelligente Umgebungen und die technische Durchdringung der Welt*, Bielefeld: Transcript, 2016, 59–62.

III.1 Capturing

The development of information-saturated environments that was predicted in the early 1990s—and is fundamentally based on the networking of miniaturized computer chips and data-collecting sensors—has been discussed, both by the avant-garde of the technological development laboratories occupied with it and in the debate that emerged later in media studies, under a series of terminological propositions: the most prominent of these suggestions are ubiquitous computing, pervasive computing, smart environments, calm technology, and ambient intelligence, alongside the term Internet of Things (IoT), which has gradually become established not only as a buzz word in industry, but also as a consumer reality.[654] The variety of phenomena and applications that can be subsumed under these terms cannot be addressed in the following any more than can the fine distinctions in etymology or in the history of theory, which, for instance, justifiably highlight the delimitable semantic fields of ›environment,‹ ›milieu,‹ and ›media ecology.‹[655] Instead, continuing the approach applied thus far of a media-logistical perspective on the distributed image—understood as a variously calculable transport product in motion—I will begin with the general question of the operational applications of image sensor technologies. Under the conditions of ›ambient‹ computing power, a proliferation of networked sensor measuring devices, and the capacity of today's data logistics, to what extent is it possible to speak of distributed imaging technology? Where does it appear and to what ends? In what regard does

654 For a general introduction, cf. Samuel Greengard, *The Internet of Things*, Cambridge, MA: MIT Press, 2015. Three comprehensive collections have sought to stake out the breadth of this field: Ulrik Ekman (ed.), *Throughout: Art and Culture Emerging with Ubiquitous Computing*, Cambridge, MA: MIT Press, 2012, and Ekman, Jay David Bolter, Lily Diaz, et al. (eds.), *Ubiquitous Computing, Complexity and Culture*, London: Routledge, 2015, as well as Engemann, Sprenger (eds.), *Internet der Dinge*. For the application-oriented discussion, cf. Hideyuki Nakashima, Hamid Aghajan, Juan Carlos Augusto (eds.), *Handbook of Ambient Intelligence and Smart Environments*, New York: Springer, 2010.

655 The widely cited starting point for such undertakings is an essay on the conceptual history: Leo Spitzer, »Milieu and Ambiance« [1948], in: *Essays in Historical Semantics*, New York: Russell & Russell, 1968, 169–218. Cf. also Florian Huber, Christina Wessely (eds.), *Milieu. Umgebungen des Lebendigen in der Moderne*, Paderborn: Fink, 2017; Florian Sprenger, »Zwischen Umwelt und *milieu* — Zur Begriffsgeschichte von *environment* in der Evolutionstheorie,« *Forum internationale Begriffsgeschichte* 3/2 (2014), 7–18; Jennifer Gabrys, *Program Earth: Environmental Sensing and the Making of a Computational Planet*, Minneapolis: University of Minnesota Press, 2016, 10ff., and Matthew Fuller, *Media Ecologies: Materialist Energies in Art and Technoculture*, Cambridge, MA: MIT Press, 2007, 1–13.

it go beyond the mere (albeit rapid) propagation of camera-equipped end devices? What data are detected optically here as light sensitivity, transformed, (temporarily) stored, examined, and distributed? The initial examination, in chapter III.1, will consider the level of image-technological acquisition. What does visual capture—the capturing of visual data in the application context of complex sensor networks—signify? How do digital image sensors relate to other sensor capacities, with which they maintain an ›ambient‹ data traffic relationship, an increasingly automated transfer relationship whose goal ultimately even includes the regular implementation of decision-making actions?

At least *one* future of the distributed image, which is becoming increasingly clearly apparent and in part is even already technologically achievable, is characterized by digital imaging processes, implemented algorithmically and embedded in comprehensive sensor systems for processing ambient data. An expansive concept of the Internet of Things—»an unruly assemblage of protocols, sensing regimes, capabilities and desires«[656]—functions as a regulating notion according to which more and more everyday objects are equipped with microchips and network access in order to shift certain processes into the ›ambience,‹ to the periphery of human perception, where they can be perpetuated discretely. In the context of translocal IoT networking, imaging technologies are cooperatively utilized in a new way, maximizing the scope and range of their capabilities. Distribution here is aimed at developing and constituting new fields of application in the everyday world, in which image-technological operations have in many cases only recently begun to occur. More and more spaces, more and more objects are now in contact with imaging processes: with visual data that are captured via optical systems and are distributable as digital data after their conversion—the associated imaging pipeline continues to lead from photons through electrons to bit patterns. Locations and effects of image sensor data collection proliferate at a pace similar to that of camera-equipped smartphones a decade earlier. Shopping refrigerators, self-driving cars, as well as front doors, children's playrooms, and birds' nests that can be visualized or observed via remote access are now paradigmatic test cases, as Ian Bogost polemically stated, of an »Internet of Things we don't need.«[657]

656 Adam Greenfield, *Radical Technologies: The Design of Everyday Life* [eBook], New York: Verso, 2017, 79ff.

657 Bogost's critique of the computerized »colonization« of the lifeworld is directed toward the big data calculations centralized in a handful of technology firms promoting such colonization (Ian Bogost, »Das Internet der Dinge, die wir nicht brauchen,« in: Christoph Engemann, Florian Sprenger (eds.), *Das Internet der Dinge. Über smarte Objekte,*

This skeptical assessment, however, does not detract from the continuing expansion of things that are equipped with imaging technology, as evidenced by products that have long since been marketable in the area of smart home security or in the field of ›intelligent‹ ambient assisted living,[658] where, for instance, processes of image sensor capturing are combined with algorithmic motion detectors and facial recognition calculations that are meant to automatically sound an alarm or call for assistance. Something similar can be said about equipping automobiles with imaging technology, where ›self-driving‹ is essentially based on the capacities of image sensor perception.[659] Numerous processes of automation—of driving, surveillance, and partly also algorithmic ›self-learning‹—are linked in one way or another with input models of visual sensing.[660] So it is precisely image sensors that bring more and more of the environment into the data space.

The expectation that the increased technologization of the image will lead not only to accelerated modes of circulation, but also to categorially different intensifications is nevertheless itself not really new, but even older than the first televisual »images from a distance,« as Paul Valéry's short essay *The Conquest of Ubiquity* suggests when it speaks, already in 1928, of how the altered modes of distribution, reaching far into the private sphere of everyday life, will lead to consequential sensory restructurings:

intelligente Umgebungen und die technische Durchdringung der Welt, Bielefeld: Transcript, 2016, 89–100).

658 Cf. Sven Fleck, Wolfgang Straßer, »Privacy Sensitive Surveillance for Assisted Living — A Smart Camera Approach,« in: Hideyuki Nakashima, Hamid Aghajan, Juan Carlos Augusto (eds.), *Handbook of Ambient Intelligence and Smart Environments*, New York: Springer, 2010, 985–1014, and Achilles Kameas, Ioannis Calemis, »Pervasive Systems in Health Care,« in: ibid., 315–346.

659 Cf. Hod Lipson, Melba Kurman, *Driverless: Intelligent Cars and the Road Ahead*, Cambridge, MA: MIT Press, 2016.

660 On the history of visual input as a problem area of computer technology, Richard Szeliski notes: »When computer vision first started out in the early 1970s, it was viewed as the visual perception component of an ambitious agenda to mimic human intelligence and to endow robots with intelligent behavior. At the time, it was believed by some of the early pioneers of artificial intelligence and robotics (at places such as MIT, Stanford, and CMU) that solving the ›visual input‹ problem would be an easy step along the path to solving more difficult problems such as higher-level reasoning and planning. According to one well-known story, in 1966, Marvin Minsky at MIT asked his undergraduate student Gerald Jay Sussman to ›spend the summer linking a camera to a computer and getting the computer to describe what it saw.‹ We now know that the problem is slightly more difficult than that« (Richard Szeliski, *Computer Vision: Algorithms and Applications*, New York: Springer, 2010, 10).

> Just as water, gas, and electricity are brought into our houses from far off to satisfy our needs in response to a minimal effort, so we shall be supplied with visual or auditory images, which will appear and disappear at a simple movement of the hand, hardly more than a sign. Just as we are accustomed, if not enslaved, to the various forms of energy that pour into our homes, we shall find it perfectly natural to receive the ultrarapid variations or oscillations that our sense organs gather in and integrate to form all we know. I do not know whether a philosopher has ever dreamed of a company engaged in the home delivery of Sensor Reality.[661]

In fact it can be argued that (audio)visual streams—their presence, availability, operativity—have by now reached a level of permeation into the lifeworld that is typically associated with infrastructures: ineluctable, available on demand, deeply embedded—and precisely because of their performance capacity, which is reflected in the case of the »home delivery of Sensor Reality« first and foremost at the level of transmission, they have become almost self-evident, ordinary. The applications of imaging technology—like the proclaimed intelligence of the objects involved, whose cooperation routines are intended to generate smart environments—are distributed, and can therefore only be understood as a cluster, in terms of their connectedness: »The real power of the concept comes not from any one of these devices; it emerges from the interaction of all of them.«[662] In many cases the intelligence in question is not really in the hands of the end device user, or is so only in a derivative form; it rather feeds on a connectivity that merely presents partial results of complex processes, usually running in distant datacenters, as a service tailored to the customer on the displays of significantly less smart digital gadgets: »The user's devices merely enable access to services that in turn access spatially remote hardware and control processes.«[663]

According to an oft-repeated formula, the general diagnosis of a qualitatively altered saturation of the environment with information technology

661 Paul Valéry, »The Conquest of Ubiquity,« in: *The Collected Works of Paul Valéry*, New York: Pantheon, 1964, 225–228, here: 226. Anne Friedberg saw the actual compatibility of his reflections in the circumstance that Valéry (although he bases this essay on artworks) is less interested in »displays« than in structural modes of distributed »delivery«; cf. Anne Friedberg, *The Virtual Window: From Alberti to Microsoft*, Cambridge, MA: MIT Press, 2006, 183–184.

662 Mark Weiser, »The Computer for the 21st Century,« *ACM SIGMOBILE Mobile Computing and Communications Review* 3/3 (1999), 3–11, here: 6.

663 Irina Kaldrack, Martina Leeker, »There is no Software, there are just Services: Introduction,« in: Kaldrack, Leeker (eds.), *There Is No Software, There Are Just Services*, Lüneburg: Meson Press, 2015, 9–20, here: 10.

assumes that personal computers will be replaced by a distributed »computing without computers,«[664] which is meant to be as ubiquitous as it is invisible, thus becoming elusive precisely by being interwoven into everyday objects and actions. Along with the miniaturization and networking of hardware, another factor contributing to this invisibility is the fact that ubiquitous accessibility is based on infrastructures such as datacenters and global cable networks, which are somewhat obscure due solely to their remote geographical location or sheer size, but from the perspective of the media economy are precisely not distributed, rather operating as largely centralized and often even in a quasi-oligopolistic manner. The ubicomp pioneer Mark Weiser, director of the Computer Science Laboratory at Xerox's Palo Alto Research Center (PARC) from 1987 until his death in 1999, who was still basing his ideas primarily on local networks,[665] never offered a deep reflection on this problem area, which is more virulent today than ever, but he did address it succinctly at one point: »If the computational system is invisible as well as extensive, it becomes hard to know what is controlling what, what is connected to what, where information is flowing, how it is being used, what is broken […] and what are the consequences of any given action […].«[666]

The status of relative invisibility, however, applies not only to the computational power made available on demand from anywhere by peripherally positioned infrastructural agents, marketed today under the generic label of cloud computing (which, counter to Weiser's prognosis, targets highly personalized mobile devices[667]), but also to a fully differentiated spectrum of data-gathering

664 Greenfield, *Everyware*, 11.

665 On this aspect, cf. Florian Sprenger, »Die Vergangenheit der Zukunft. Kommentar zu ›Das kommende Zeitalter der *Calm Technology*,‹« in: Sprenger, Christoph Engemann (eds.), *Das Internet der Dinge. Über smarte Objekte, intelligente Umgebungen und die technische Durchdringung der Welt*, Bielefeld: Transcript, 2016, 73–88.

666 Mark Weiser, Rich Gold, John Seely Brown, »The Origins of Ubiquitous Computing Research at PARC in the Late 1980s,« *IBM Systems Journal* 39/4 (1999), 693–696, here: 694f.

667 The model of ubiquitous computation that has become established operates, as Paul Dourish and Genevieve Bell have shown, by means of mobile end devices and services, and less by means of the »fixed embedded intelligence« predicted by Weiser: »Weiser foresaw a world in which computation would be embedded into our daily worlds—not just physically embedded, but also socially and procedurally embedded, becoming part and parcel of how we act. It has not, perhaps, taken the form that he expected, although personal digital assistants, cell phones, large-scale displays, and digital cameras do bear family resemblances to the devices that Weiser imagined would come to populate our society. Nevertheless, the fact that the details are different should not blind us to the remarkable accuracy of Weiser's vision. Computation is embedded into the technology and practice of everyday life; we continually use computational devices without thinking

sensors, which operate ambiently insofar as they are now »embedded« in all manner of everyday objects, as Adam Greenfield writes: »In this context, ›ubiquitous‹ meant not merely ›in every place,‹ but also ›in every thing.‹ Ordinary objects, from coffee cups to raincoats to the paint on the walls, would be reconsidered as sites for the sensing and processing of information.«[668] Weiser himself called this development »embodied virtuality«: »a process of drawing computers out of their electronic shells. The ›virtuality‹ of computer-readable data—all the different ways in which it can be altered, processed, and analyzed—is brought into the physical world.«[669]

In his vision of a proximate future grounded in the »technomyth,«[670] however, Weiser's reflections are primarily based in perceptual psychology, or the economics of attention, and suggest that there will emerge an ideally ›interfaceless‹ relationship between humans and computer technology, relieved of the burden of information overload. As to the sensors involved in this ambient scenario supported by »calm computing,«[671] his works only contain general remarks such as this: »In the end, ubi-comp created a new field of computer science, one that speculated on a physical world richly interwoven with sensors, actuators, displays and computational elements, embedded seamlessly in the everyday objects of our lives and connected through a continuous network.«[672] On the media-logistical details of the likewise continuous ambient capture of data by sensors, he merely writes: »When almost every object either contains a computer or can have a tab attached to it, obtaining information will be trivial.«[673]

Hardly trivial, at any rate, is the enormous expansion and sophistication of sensor capabilities, which deploy highly varied operating principles in order

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of them as computational in any way. The desktop computer has not been displaced but instead augmented. From the perspective of an ubicomp of the present, we can note that Weiser was entirely correct in one regard: the purposes to which people would put computational devices are not radically new ones but rather reflect existing social and cultural practices. However, this did not necessarily take the form that had been anticipated. Computational technologies are embedded in social structures and cultural scripts of many sorts; ubicomp technologies prove also to be sites of social engagement, generational conflict, domestic regulation, religious practice, state surveillance, civic protest, romantic encounters, office politics, artistic expression, and more« (Paul Dourish, Genevieve Bell, *Divining a Digital Future. Mess and Mythology in Ubiquitous Computing*, Cambridge, MA: MIT Press, 2011, 41–42).

668 Greenfield, *Everyware*, 11.

669 Weiser, »The Computer for the 21st Century,« 4.

670 Cf. Dourish, Bell, *Divining a Digital Future*.

671 Weiser, Gold, Brown, »The Origins of Ubiquitous Computing Research,« 695.

672 Ibid., 694.

673 Weiser, »The Computer for the 21st Century,« 11.

to measure distinct characteristics of the environment and convert the results such that they can be transferred and fused with layers of data detected in other ways. Samuel Greengard has described sensors as »the eyes, ears, nose, and fingers« of the Internet of Things and offered an exemplary overview of the spectrum this invokes:

> Today devices can detect and measure minute concentrations of pollution or toxic substances in the atmosphere or water supply. They can detect incredibly tiny changes in structures, such as bridges and tunnels, by measuring vibration. Sensors in vehicles allow cars to park themselves and detect when another vehicle on the road is too close. Meanwhile motion sensors in security and video systems provide alerts when an event or change takes place. […] To be sure, thousands of different types of sensors now exist, incorporating light, sound, magnetic fields, motion, moisture, tactile capabilities, gravity, electrical fields, chemicals, and much more. […] They can incorporate multiple functions on a single microchip and they rely on a common binary code to transmit and receive data in real time.[674]

The translation of variously captured measurements into a digital data form that is ›universally‹ compatible and thus able to circulate logistically within sensor networks as a real-time stream between sensor units that are sending and receiving in equal measure—this generates an environment that is composed of numerous layers of data as a »communication system«[675] (Nigel Thrift) and relational entity. The more distributed the sensors and the (physical, chemical, material) spectrum of detectable characteristics, the more saturated with information and granularly adjustable is the environment. As John Durham Peters writes in his sweeping, encyclopedic ›natural philosophy‹ theory of digital media, the »chaotically« proliferating digital computation units and sensors become effectively environmental because, in the context of the Anthropocene, they precipitate as a premise for action in the foundational layers of our »habitats.« While the twentieth century was still dominated by mass media and its production of meaning, the most recent new media, according to Peters, brings a return to older media technologies that can be

674 Greengard, *The Internet of Things*, 121–122.

675 Nigel Thrift, »Closer to the Machine? Intelligent Environments, New Forms of Possession and the Rise of the Supertoy,« *Cultural Geographies* 10/4 (2003), 389–407, here: 392.

defined primarily by their »logistical« functions.[676] Peters explains the continuing expansion and distribution of these revitalized logistical media, which are migrating into numerous things—»computers have spread almost zoologically«—by pointing out that they simply lack »natural enemies« in the habitats in question.[677] On the contrary, in Peters's view, ever more powerful infrastructures, which can be »hard« (like fiber glass cables) or »soft« (like transmission protocols)[678]—and moreover, »messy« in reality[679]—offer ideal living conditions, namely network connection to and data exchange with other computing sensor ›populations‹ that are also geared not toward suppression, but connection, and thus count on the reproductive proliferation of things that are not just web-enabled, but also capable of perception on the levels of data capture and data communication.

The dynamic postulated here only knows one vector. More and more sensors are networked with an ever finer weave and detect a constantly growing number of the widest variety of environmental characteristics—the capacity of the Internet of Things to capture information with sensors continues to grow in expanse and sophistication. The significance of this, writes Matthew Fuller, is that the emerging information circuits are increasingly geared in such a way that they can generally dispense with operational contributions of human agents altogether: »[…] the vast majority of ubiquitous computing refers […] simply to itself, consisting of networks of sensors, actuators, finite-state machines, maintaining homeostatic levels, feeding and tracking

676 »Digital media reactivate not only these old limbic fluids, but older forms of data use. Unlike the mass media of the twentieth century, digital media traffic less in content, programs, and opinions than in organization, power, and calculation. Digital media serve more as logistical devices of tracking and orientation than in providing unifying stories to the society at large. Digital media revive ancient navigational functions: they point us in time and space, index our data, and keep us on the grid« (John Durham Peters, *The Marvelous Clouds: Towards a Philosophy of Elemental Media*, Chicago: University of Chicago Press, 2015, 7).

677 Ibid., 49.

678 Ibid., 34.

679 »›Mess‹ refers […] to the way that technological realities are always contested. No single idea holds about what technologies are and what they do. Though many have tried, attempts to reduce this complexity to a single reading are at best unsatisfactory; as Andrew Pickering […] observes, ›Ontological monotheism is not turning out to be a pretty sight.‹ So partly our concerns with mess highlight not just an interest in ›how things could have been different‹ but rather how they already are different among the different groups, places, contexts, and circuits that characterize contemporary ubicomp« (Dourish, Bell, *Divining a Digital Future*, 5).

information from one integrated circuit to another. The human subject may come late in the chain if at all.«[680]

The »calming effect« of these computerized environments that Weiser foresaw—if it empirically exists at all, which is highly doubtful in view of the current range of products in digital technologies, laden with commodity fetishism[681]—is therefore based on the idea that it is only occasionally necessary to draw on human users' powers of perception and consciousness. On one hand, many processes operate in opaque, inaccessible, interfaceless, black-boxed backgrounds of ubiquitous computation, from which, on the other hand, continuous sensor observation of human action and behavior is organized. This situation attests to the fact that image sensors are particularly effective data-behavioristic tools,[682] because—as one topos of the debate about ›smart‹ cities holds—they are specialists in the inconspicuous »tracking of visible actions.«[683] Their ›calmness‹ is due to a strategic positioning: they observe from a relative distance—taking sensory notes on all kinds of things without having to ask permission.

Generally speaking, sensors are recording, ›feeling‹ detectors that translate—primarily physical and chemical—stimuli into electrical signals.[684] Once these are collected, they can for their part be digitally transformed, stored, distributed further. If sensor nodes are communicatively connected as data points, this gives rise to sensor networks, which can exchange, fuse, calculate, and ultimately implement the data in decision-making actions, as Jennifer Gabrys maintains in her media-ecological study *Program Earth*: »[...] sensors are generating stores of data that, through algorithmic parsing and processing, are meant to activate responses, whether automated or human-based, so that a more seamless, intelligent, efficient, and potentially profitable set of processes may unfold.«[685] In particular, ad hoc sensor networks are characterized by self-organization and adaptability. They consist of miniaturized nodes (the RAND Corporation floated the appropriate buzz word »smart dust« at the beginning of the 1990s), whose energy needs are meant to be kept as low as possible through sleep and wait modes. If the sensor detects an event, it become a sender, waking up the surrounding nodes and, if necessary, providing them

680 Matthew Fuller, foreword to Ulrik Ekman (ed.), *Throughout: Art and Culture Emerging with Ubiquitous Computing*, Cambridge, MA: MIT Press, 2012, xi–xxxi, here: xxviii.

681 Bogost, »Das Internet der Dinge, die wir nicht brauchen,« 93.

682 Cf. Rouvroy, »The End(s) of Critique.«

683 Mike Crang, Stephen Graham, »Sentient City: Ambient Intelligence and the Politics of Urban Space,« *Information, Communication & Society* 10/6 (2007), 789–817, here: 812.

684 Cf. Jon S. Wilson (ed.), *Sensor Technology: Handbook*, Oxford: Newness, 2005.

685 Gabrys, *Program Earth*, 8.

with further information, which then gives rise to trajectories of activation and message chains. In order to explore the image-technological applications that are involved with this homeostatic self-regulation model, which is generally detached from intentional conscious action by human agents, an initial look at the field of distributed image sensor acquisitions will be useful.

Image sensors capture visual data by means of light-sensitive electronic elements (usually the CCD sensors mentioned above or CMOS sensors, also based on the photoelectric effect, which transport the electric charge with greater energy efficiency and are more economical, but also less light-sensitive[686]). The expansion and differentiation of the sensor technologies being deployed—the »growing sensorization of environments«[687]—leads in part to a rapid increase in the image data circulating in the transmission channels involved, as demonstrated, for example, by the IoT search engine Shodan[688] or platforms like Opentopia, in which unencrypted webcam streams from private home security systems are siphoned out of the so-called home networks and brought into public view.[689] Constantly transmitting image data streams like these can only be connected to a limited degree with the general proliferation of images primarily triggered by smartphone cameras, which is understandably usually interpreted as a (post-)photographic intensification.[690] The components of media technologies of visual capture employed in sensor networks are indeed also used in ordinary mobile phone cameras. However, the logic of visual saturation that is implemented in sensor networks is aligned with different principles of data sharing, of producing and distributing sensing and visibility. The reorientation of imaging technology—from digital image practices *everywhere* fueled by social media to the ambient distribution model of sensors *everyware*—leads to a redistribution of agency: to new agents, locations,

686 Cf. JongHo Park, »CMOS Image Sensor for Smart Cameras,« in: Chong-Min Kyung (ed.), *Theory and Applications of Smart Cameras*, New York: Springer, 2015, 3–20.

687 Gabrys, *Program Earth*, 4.

688 Cf. https://www.shodan.io. On this topic in general, cf. Greenfield, *Radical Technologies*, 104ff. On the DDoS (distributed denial of service) risk area that arises through a lack of security protocols, cf. ibid., 108ff.

689 »Opentopia is the first and biggest website that catalogues live webcams found automatically in search engines. We use a variety of clever search techniques to find new cameras. Users can also suggest new cameras to add« (Opentopia — About, http://www.opentopia.com/about.php). For a qualitative social research approach to the user perspective on such self-surveillance practices, cf. Liisa A. Mäkinen, »Surveillance On/Off: Examining Home Surveillance Systems from the User's Perspective,« *Surveillance & Society* 14/1 (2016), 59–77.

690 Cf. Fetveit, »The Ubiquity of Photograpy.«

transport routes, depots of visual acquisition, whose communitive operativity is shifted in the direction of a »machinic connectivity.«[691]

There is thus a deprivileging of human agency on the horizon of these developments. The ambient data of distributed sensing are meant to be machine-readable, automatically analyzable. First, computable, networked sensors migrate into environments in order to bring them forth as data spaces and make them calculable. The capturing process runs through environmental relations and is linked with a constitutive achievement: »The becoming environmental of computation then signals that environments are not fixed backdrops for the implementation of sensor devices, but rather are involved in processes of becoming along with these technologies. Environment is not the ground or fundamental condition against which sensor technologies form, but rather develops with and through sensor technologies as they take hold and concresce in these contexts.«[692] Media technologies of networked sensing collect, transport, process data—gathered according to mechanical, thermoelectric, magnetic, optical operating principles, among other things—in order to capture environmental conditions in a variety of modes, to develop them and make it possible to control them through information technology.

If computation becomes environmental in this sense, and environments are shifted into the realm of their ›programmability‹ through sensor monitoring, then the collection of visual data involved in this—as one specific form of sensor input among others[693]—also follows a novel media-logistical calculus of distribution. The circuits of information in sensor networks are geared toward automatic processes of data exchange, which make it possible for the captured data—sometimes compiled according to differing operating principles—to

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691 »The drive to instrument the planet, to make the earth programmable not primarily from outer space but from within the contours of earthly space, has translated into a situation where there are now more ›things‹ connected to the Internet than there are people. Some commentators suggest that the defining moment for implementing the Internet of Things was in 2008, when machinic connectivity to the Internet outnumbered human connectivity. Sensing occurs across things and people, through environments and within infrastructures. People-to-people communication is becoming a smaller proportion of Internet and networked traffic in the complex array of machine-to-machine (M2M), machine-to-people (M2P), and people-to-people (P2P) circuits of communication« (Gabrys, *Program Earth*, 7).

692 Ibid., 9.

693 »Sensing (broadly understood) in this arrangement has to do with all the ways in which computers input data into internal calculative processes in order to output data in another form. Sensors (as more specific input devices) emerged within this computational arrangement as just one of many possible devices for inputting data into the machine« (ibid., 10).

be correlated. This also includes the fact that the sensor acquisitions must be localizable in order to generate a situational ›total image‹ from the concurrent relations. The more sensors that are involved in its creation, the more ›high-resolution‹ this ›image‹ of the environment will be. Provided that these sensor data are deposited in storage units, new kinds of archives also emerge, which load the networked things with growing media-historiographical information holdings, with history: »Products, such as clothes, vehicles, fridges, maps, houses, phones, are likely to carry a knowledge content, which not only renders them ›smart‹ but has the potential to render them capable of remembering past use and modifying themselves to facilitate future use. The physical world has become an information system formed by networks of sensors and actuators embedded in objects that have an increasingly active role in shaping the processes of their own production and are capable of creating memory architectures pertinent to their own use. In this sense, objects will become their own archive.«[694]

The sensors that are distributed for purposes of observing the environment collect data that is fused, secured, and algorithmically processed in superordinate storage units—which Christoph Engemann and Florian Sprenger have highlighted as a question about the relationship between distribution and centralization: »Is the gadgets' intelligence local or are the local gadgets just interfaces of a remote, potentially centralized ›intelligence‹?«[695] Data transport, in any case, remains at the level of sensors communicating among one another only in exceptional cases, which is why, following Katherine Hayles, they can be understood as »sub-cognizers«: »[…] distributed cognition concentrates on creating complex interrelated systems in which small sub-cognizers that perform within a very limited range of operation are combined with readers that interpret that information, which in turn communicate with relational databases that have the power to make correlations on much wider (and extensible) scales.«[696]

From the viewpoint of application-oriented research, the future does indeed belong to image sensor technologies in many areas—from a logistical perspective, however, there remain numerous questions of ›intelligent‹ distribution,

694 Gabriella Giannachi, *Archive Everything: Mapping the Everyday*, Cambridge, MA: MIT Press, 2016, 161.

695 Engemann, Sprenger, »Im Netz der Dinge. Zur Einleitung,« 44.

696 N. Katherine Hayles, »RFID: Human Agency and Meaning in Information-Intensive Environments,« *Theory, Culture & Society* 26/2–3 (2009), 47–71, here: 48. On Hayles's model of »distributed cognition« or »cognitive assemblages« cf. also: Hayles, *Unthought: The Power of the Cognitive Nonconscious*, Chicago: University of Chicago Press, 2017.

precisely also with regard to processing: »[…] a camera is smart if it can detect objects. Is it an animal or a person walking by? Is it someone living here or a passerby? Is this a normal action, or is something suspicious happening? It makes no sense to continuously stream all images to the cloud. The camera should be able to do some local processing and send only the relevant images. If not, we'll inevitably get issues with the quantity of data that has to be transmitted. So, also smart processing and the ability to only send relevant images is essential for a smart camera.«[697] From this perspective, the growth of visual capture in the framework of various sensor networks demands transmission calculations different from those required in the unchecked proliferation of images on social media platforms, from Facebook Live to Periscope to Twitch, which likewise seem to be increasingly reliant on permanent transmission modes in the form of video livestreaming, but do not use any ›smart‹ discrimination filters.[698]

A purely quantitative interim assessment would accordingly point out that simply more and more digital images are being acquired with less and less effort and are being distributed more and more instantaneously. But do these phenomena—the ubiquity of the image motivated and channeled by ›social media‹ and the equally ›omnipresent‹ role of the image in the ubicomp context—belong together at all? On this point Jennifer Gabrys has argued—among other things, in view of a webcam pointed at a mossy surface in the James Reserve nature park in California[699]—that the systemic status of collected image data is transformed under the aegis of sensors:

697 Piet De Moor, »Image Sensors for a Smart Environment,« *Fierce Electronics Sensors Insights*, February 20, 2015. https://www.fierceelectronics.com/components/image-sensors-for-a-smart-environment.

698 Cf. Kathryn Nave, »Entertainment, News, or Real Life? Live Streaming is Complicated,« *WIRED*, January 5, 2017, https://www.wired.co.uk/article/live-now-periscope-twitch-facebook-live.

699 Thanks to motion sensors, squirrels interested in this mossy area have also already come into view there: »Biologists at the James San Jacinto Mountains Reserve in southern California stumbled upon a tiny discovery in the world of squirrels a few months back. It turns out that the little guys, heretofore known to exist on nuts and berries, have a thing for moss; they munch on it for the moisture. No one knew; no one had been in the right place at the right time to see it. But the squirrel in California was caught in the act when the animal tripped a 7.5-centimeter-square motion sensor that fired up a tiny wireless camera to record the event. The small sensor is one of dozens of digital spectators linked into a speedy wireless network and sprinkled across a 12-hectare patch of wilderness 40 kilometers southwest of Palm Springs. The devices take note of the movements of animals, plant growth and such factors as time, temperature, air pressure, wind speed and changes in carbon use« (Benjamin Fulford, »Sensors gone wild,« *Forbes Magazine*, February 28, 2002).

> Web cameras, camera traps, animal-borne cameras, and eco-drones now operate within sensor networks, and the images they produce are often processed as another mode of (image-based) sensor data. These shifts in the practices of processing image data as sensor data are productive of sensor environments that create distinctly different engagements with imaging, not necessarily as an a priori fixation of visuality, whether as an epistemological or disembodied register, but instead as a processual data stream that irrupts in moments of eventfulness and relevance across data sets comprised of multiple sensor inputs. Image sensor data, in this case, is part of sensor systems.[700]

If image practices are viewed in this sense as sensor practices, it is less a matter of visual output and image forms than continuous data streams that can be programmed, for instance, according to the observational agendas of remote viewing, and accrue to an »invisible visual culture.«[701] To stay with the capturing processes involved in this: In numerous fields of application it is in fact primarily image sensors that appear as »addressing media«[702] and datafy environments with information technology. Objects that are still not ›smart,‹ such as the actual refrigerator contents that never see the light, are brought into the Internet of Things through their visual capture—in Samsung's »Family Hub RB 7500,« for example, through three high-resolution image sensors whose data also flow to a real-time video stream that can be called up on a smartphone—which is a general procedural rule in application-oriented discourse: »vision as a high-level way of capturing information from an environment.«[703]

The enormously powerful HD image sensors on the newest generation of Google's Street View camera cars have to do with the fact that the first step in the continuing refinement of this proprietary »algorithmic index of the physical world« is dependent on the resolution of the visually captured environmental data, which than can be processed accordingly as ›training data‹: »[HD images are] there to feed clearer, closer shots of buildings and street signs into Google's image recognition algorithms. Those algorithms can pore over

700 Gabrys, *Program Earth*, 58.

701 Trevor Paglen, »Invisible Images (Your Pictures Are Looking at You),« *New Inquiry*, December 8, 2016, https://thenewinquiry.com/invisible-images-your-pictures-are-looking-at-you/.

702 Engemann, Sprenger, »Im Netz der Dinge. Zur Einleitung,« 35.

703 Juan Carlos Augusto, Hideyuki Nakashima, Hamid Aghajan, »Ambient Intelligence and Smart Environments: A State of the Art,« in: Nakashima, Aghajan, Augusto (eds.), *Handbook of Ambient Intelligence and Smart Environments*, New York: Springer, 2009, 3–31, here: 6.

millions of signs and storefronts without getting tired. By hoovering up vast amounts of information visible on the world's streets—signs, business names, perhaps even opening hours posted in the window of your corner deli—Google hopes to improve its already formidable digital mapping database. […] Earlier this year […] Google's cloud division showed they could predict income, race, and voting patterns for US cities with software that logs the make, model, and year of cars in Street View Photos.«[704]

The trajectory of the geomedial indexing of real topography thus no longer only aims to include ever more spaces—for whose expansive coverage the provider now puts cameras in backpacks, screws them onto trolleys, tricycles, and snowmobiles in order to measure hiking trails, museums, car-free parks, and alpine terrain[705]—but increasingly seeks to deepen and consolidate the information that can be obtained via the acquisition modes of visual capture: »Sensor networks […] always transform places, facts, and circumstances into machine-readable code.«[706] To this end, numerous monitoring and tracking systems are based on so-called smart cameras, which localize and identify objects, persons, environmental aspects, making it possible to transmit them as data points.[707]

In the Internet of Things, intelligent cameras are special (and especially intrusive) things insofar as they are able to capture other things (and processes) locally without their active participation, store them visually and link them with an address. And it is precisely ›unnetworked‹ things that thus become ›readable,‹ things that (more or less intentionally) do not carry a transponder and yet in the course of their visual detection nonetheless appear in the global space of IoT addressing, namely as image-based sensor data and in relation to

704 Tom Simonite, »Google's New Street View Cameras Will Help Algorithms Index the Real World,« *WIRED*, September 5, 2017, https://www.wired.com/story/googles-new-street-view-cameras-will-help-algorithms-index-the-real-world/. The article refers to a research project at Stanford University: cf. Timnit Gebru et al., »Using deep learning and Google Street View to estimate the demographic makeup of neighborhoods across the United States,« PNAS 114/50 (2017), 13108–13113, https://doi.org/10.1073/pnas.1700035114, and Timnit Gebru, Jonathan Krause, Yilun Wang, Duyun Chen, Jia Deng, and Li Fei-Fei. »Fine-Grained Car Detection for Visual Census Estimation«. Proceedings of the AAAI Conference on Artificial Intelligence 31/1 (2017). https://ojs.aaai.org/index.php/AAAI/article/view/11174. Cf. also Steve Lohr, »How Do You Vote? 50 Million Google Images Give a Clue,« *New York Times*, December 31, 2017.

705 Cf. Google Street View, https://www.google.com/streetview/understand.

706 Abend, *Geobrowsing*, 17. On Street View as a principle of geomedial visualization, cf.: ibid., 141.

707 Cf. Chong-Min Kyung (ed.), *Theory and Applications of Smart Cameras*, New York: Springer, 2015.

the position of ›space-consuming‹ image sensor acquisitions. Sensor types like motion detectors may capture unnetworked things, but they operate with comparatively ›low data‹ acquisitions, whose scope for further processing is more limited. »A high-level way of capturing information,« by contrast, means not least that more patterns tend to be algorithmically extractable and modellable from image data storage than from data collections originating from other sensor registers without comparable ›surplus data.‹[708] A supermarket's video feed can provide information about the behavior, movement patterns, and demographics of consumers beyond the security agendas that are identified as having priority, because all this information can be extracted from the stream of images. One technology platform at ETH Zurich, called VarCity, uses a variety of image-based information storage—starting from specially prepared aerial photographs and 360° panorama images collected using cars, more or less publicly accessible webcam, drone, dashcam footage, to the network productivity of tourists indexing the city with smart phone cameras and feeding this into social media—to generate semantic 3D models of urban spaces through a combined processing of this massive input of images.[709] Crowd-sourced image data that come into existence for completely different (or no direct) purposes can be adduced as sensor data for instrumental agendas that relate to the same segments of the environment.

Sensor monitoring primarily occurs »passively,« in the background: »The action of the sensor is automatic and receptive. Sensors don't watch and listen so much as they detect and record. […] These devices […] partake of the logic of sensing as a form of passive monitoring, and can be treated as, among other things, components of an increasingly comprehensive, albeit distributed and often disarticulated sensing apparatus.«[710] »Remote« is a significant catchword in many fields of application. It often indicates that detection can occur

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708 To the extent that image-based sensor data captured in this way are associated with permanent storage, they can be distinguished from other functional images that are operatively limited as » disposable images without an afterlife« (cf. Hinterwaldner, *Einwegbilder*).

709 »We process images of real cities automatically and efficiently to create parameterized and semantic 3D models, in which streets, buildings and vegetation are discriminated, and the number of floors, positions and shapes of windows, doors and balconies are recognized and encoded. Our research further fills our static 3D city models with dynamic content by extracting special events and traffic flows from images, and by generating a city-scale motion and activity model. One can virtually visit the Munsterhof in Zurich and see a video summary of recent events there, or check out traffic densities along the kids' way to school« (http://www.varcity.ethz.ch/).

710 Mark Andrejevic, Mark Burdon, »Defining the Sensor Society,« *Television and New Media* 16/1 (2015), 19–36 [open access: 1–21, here: 7].

from the distance of a technologically constituted viewing relation, hence automatically, without the authorization of those who are captured, which is increasingly being effectively implemented, for instance, in biometrical evaluations by multicamera systems: »[…] one of its main advantages over other biometrics […] is that it operates at a distance and does not require consent or participation.«[711] In the recent past, test runs on »intelligent video analysis« in the Chinese city of Shenzhen[712] and in Berlin's Südkreuz train station[713] have pointed to an already quite concrete interest on the part of state security services in such capturing technologies that operate ›at a distance.‹

It is precisely security and surveillance technologies that define the fields of action—which they have taken on the task of monitoring—with the range of the information acquired by concurrent visual capture. Anything that does not end up inside the frame of the image data—in one of those high-resolution and, as in the case of recent drone camera systems,[714] remotely captured sections of the world, which can be multiplied ubiquitously and combined more and more ›seamlessly‹—remains outside the synthesized data spaces. Those who enter into one of these numerous image-data fields can be positioned and potentially obtain a transferable address with which they can be localized and identified, at least temporarily, by data traffic technology. This expands on a general IoT principle of media positioning, in which »objects are not only continually assigned addresses in the transfer, but are localizable within networks from the positions of other objects, which themselves all act as agents of dissemination.«[715] The more connected things are, the more localizable they are. Whatever appears to be unconnected can be drawn into the network by image sensors, datafied by them, and thus become localizable and addressable.

The nexus between developments in imaging technology and expanding surveillance practices, which is also particularly evident in terms of media history from the perspective of surveillance studies,[716] undoubtedly discovers new investigative potential when data acquired by image sensor technology appear in the algorithmic circuits of »big dataveillance«[717]: from crowd

711 Kember, »Face Recognition and the Emergence of Smart Photography,« 186.

712 Josh Chin, Liza Lin, »China's All-Seeing Surveillance State Is Reading Its Citizens' Faces,« *Wall Street Journal*, June 26, 2017.

713 Matthias Monroy, »Überwachungslabor Berlin-Südkreuz: Tracking und Gesichtserkennung geplant,« Netzpolitik.org, March 23, 2017, https://netzpolitik.org/2017/ueberwachungslabor-berlin-suedkreuz-tracking-und-gesichtserkennung-geplant/.

714 Cf. the Center for the Study of the Drone, https://dronecenter.bard.edu.

715 Engemann, Sprenger, »Im Netz der Dinge. Zur Einleitung,« 35.

716 Cf. David Lyon, *Surveillance Studies: An Overview*, Cambridge, UK: Polity Press, 2007, 71ff.

717 David Lyon, »Big Dataveillance: Emerging Challenges [Draft],« 2016, in: https://docslib.org/doc/4822627/big-dataveillance-emerging-challenges-david-lyon.

monitoring[718] to personal identification on the basis of algorithmic facial recognition.[719] In an essay that appeared already in 1994, Philip E. Agre still attempted to understand surveillance as a visual paradigm (with a panoptical core) and to distinguish it from capturing as an information-technological process—which in his view is discussed not in terms of visual, but linguistic metaphors—in terms of ideal types, despite the many hybrid forms. The starting point here was the conjuncture at the time of real-time tracking technologies such as the active badge localization system in Mark Weiser's ubicomp project at Xerox. Agre understands capturing as a socio-technical acquisition process in which »grammars of action« are applied to chains of action that are sequenced in an almost Taylorist manner, which leads less to their ›representation in computer language‹ than to restructurings and feedback: »Human activity is thus effectively treated as a kind of language itself, for which a good representation scheme provides an accurate grammar. […] The capture model describes the situation that results when grammars of action are imposed upon human activities, and when the newly reorganized activities are represented by computers in real time.«[720] The »grammar« of such a sequence of action analyzed by information technology is thus not ›discovered‹ and represented as true to reality, but newly constituted by the application of an abstract model: »[…] a system can track only what it can capture, and it can capture only information that can be expressed within a grammar of action that has been imposed upon activity.«[721] While surveillance occurs primarily in the service of intelligence, according to Agre, from the distance of a gaze codified—at least in terms of its genealogy—by the government, capturing

718 Cf. Meyer, »Augmented Crowds.«

719 Dietmar Kammerer writes the following on the current power and ›image enthusiasm‹ of such technologies: »It is not individual identification (this is taken on by the ›super recognizers‹), but the pattern recognition by type that is delegated to image-recognizing computers (›video analytics‹). If one defines an undesired action or an event generally enough, this is automatically recognized and reported for further review by human observers. […] Imagine if such systems for analyzing images were unleashed on the large network of images: on all image data in the cloud, in social networks, or in the image archives of state security authorities. On a voluntary basis this already occurs legally now. During catastrophes and terrorist attacks, such as the attack on the Boston Marathon, the population is called on to send their private image material to be evaluated by investigative authorities. So in the present time, every private filming of a large-scale event is potentially a document of forensic investigation, a component of security police action. Secret services with unrestricted access to the image data banks of online memory would not even (or don't even) have to ask for permission« (Dietmar Kammerer, »Videoüberwachung,« *POP. Kultur und Kritik* 9 (Autumn 2016), 16–32, here: 32).

720 Agre, »Surveillance and Capture,« 108–109.

721 Ibid., 114.

requires quasi-linguistic translation operations, on the one hand, and on the other, complicated socio-technological negotiation processes ›on site‹ (which requires cooperation and enables resistance).

But what happens when tracking and capturing no longer have to draw on previously invested grammars of action? In some passages, Agre refers to scenarios of distributed sensors—»that actively seek out the entities being tracked«[722]—but he nonetheless assumes that legitimate surveillance agencies would only gain access to ›ubiquitously‹ captured and ultimately internetworked data in dystopian visions:

> Whereas the surveillance model suggests that the resulting masses of data would be gathered and stored in the same central location, the capture model is agnostic on this matter. Indeed, the capture model emphasizes that capture, as a specifically social process, is not a unitary phenomenon. To the contrary, every domain of activity has its own historical logic, its own vocabulary of actions, and its own distinctive social relations of representation. As a result, information gathered through capture in one domain of activity may or may not be commensurable with information captured in another domain.[723]

In contrast, from today's perspective one can object that image sensor modes of capture, which are bringing more and more sections of the world into the data image and distributing them in the form of real-time streams, are not dependent on previously invested models of action (or are only so with regard to recording locations), and that global addressing spaces tend to emerge through the general fusion and networking of data streams. It is precisely the image data storage units clogged by visual capture that enable tracking without prescribed grammars of action. Indeed, at one point Agre himself speaks of video camera systems, but at that time he could only conceive of their monitoring principle of undetermined recording and later processing as text based: »A variety of projects […] have sought alternatives to the engineering strategy of thoroughgoing capture, through schemes that allow people to record information in the form of computerized text […] without imposing any detailed grammar on it. The stored material can later be retrieved and interpreted by others.«[724]

722 Ibid., 104.
723 Ibid., 116.
724 Ibid., 113.

With ubiquitously distributed image sensors, it is precisely this possibility that increasingly merges into the ever expanding, ever more granularly structured field of visual capture. Image data that tend to be ›ubiquitously‹ gathered—whose positioning is in any case no longer limited to the acquisitions made by conventional surveillance camera systems—are for this very reason stored at least on a medium-term basis, in order to be available for consultation at later points in time as sensor input data for analyses and pattern recognitions that can, in principle, be programmed at will. The fact that the numerous »logjects«[725] of the Internet of Things, constantly equipping themselves with data traces, regularly register information beyond the instrumental functions that are immediately recognizable to the user has by now at least occasionally forced its way into general public discourse—for instance when the FBI attempted (officially to no avail) to put the network speaker »Alexa,« marketed as an assistant system, (or Amazon's Cloud, with which it maintains a continuous relationship of exchange) on the witness stand,[726] which could soon also easily happen to a smart refrigerator with image sensor capacity such as Samsung's »Family Hub RB 7500.«[727]

Against the backdrop of this anecdotal evidence of a »Commissioner Refrigerator« looming on the horizon, we can articulate the following in transition to the closing chapter. If, for instance, investigative authorities begin to evaluate automatically generated refrigerator images that circulate as a stream in sensor networks, they are in fact initially simply consulting another (albeit unusual) visual crime scene document, evaluating it according to the hermeneutic rules of their institutional practice. But it is also interesting that in this process the ›ambientalized‹ capture routine of the smart thing is interrupted for the sake of exploring the margins of its perception that are registered less

725 Cf. Rob Kitchin, Martin Dodge, *Code/Space: Software and Everyday Life*, Cambridge, MA: MIT Press, 2011.

726 Cf. Gerald Sauer, »A Murder Case Tests Alexa's Devotion to Your Privacy,« *WIRED*, February 28, 2017.

727 Cf. Adrian Lobe, »Wenn der Kühlschrank zum Kommissar wird,« *Neue Zürcher Zeitung*, January 20, 2017. Mark Weiser had spoken already spoken of »rogue tabs« in this regard: »In addition to showing some of the ways that computers can find their way invisibly into people's lives, this speculation points up some of the social issues that embodied virtuality will engender. Perhaps key among them is privacy: hundreds of computers in every room, all capable of sensing people near them and linked by high-speed networks, have the potential to make totalitarianism up to now seem like sheerest anarchy. Just as a workstation on a local-area network can be programmed to intercept messages meant for others, a single rogue tab in a room could potentially record everything that happened there« (Weiser, »The Computer for the 21st Century,« 9).

›intelligently.‹ For the refrigerator's calculus, according to its mandate, is interested not in recording the murder in the kitchen that is peripherally registered by an open refrigerator door, but in assessing the quantity of remaining milk cartons, or the number to be ordered. Or in more fundamental terms: The thing equipped with image sensors is founded on a differently distributed understanding of image, data, and their readability.

III.2 Redistributing

The ubiquity of digital images results in part from the efficiency with which media logistics enable instantaneous distribution. At the same time, however, it is an effect of another distribution: the proliferative expansion of various networked things that are equipped with imaging technology. The agency of the ›ambient‹ image infrastructure is distributed over a number of key players, ranging from technological agents of visual capture by sensors to agents of data mobilization, processing, and visualization. The ›visual culture‹ of the expanding Internet of Things follows calculations that are likewise algorithmically formalized and thus dependent on the general datafication of the image. Nonetheless, noticeably less logistical energy is invested here in the production and transportation of visual surfaces.

Even under the conditions of »ubiquitous sensing,«[728] of course, the image does not completely disappear as a phenomenal ›data exterior.‹ It remains an option to display certain data states, to make them specifically intelligible. With regard to the attention economy as well as operationally, however, a shift in the direction of the periphery is taking place. Here, image data circulate as sensor data, which are passed on more or less directly—that is, without visual mediation—to further information-technological processing. Fully in line with Weiser's vision, the distributed image acts as a muted signal that remains effective and is able to mediate operational decisions according to protocol without further raising the level of the general information overload. As ambient signals, distributed images thus serve to create structure, opening and closing fields of action, but generally withdraw from visible zones of (conventional) visual culture.

While a comprehensive model of image data traffic is predominant in the context of the Internet that is oriented toward platforms and human users (›Web 2.0‹)—a model that transmits the streams circulating within it according to the standards of computer network protocols: now in ›real time,‹ potentially infinitely and according to the specifications of an economy of data feedback—sensor technologies for their part have been miniaturized, differentiated, and wired, and through processes of data exchange and data fusion they generate environments that are modeled in ever more detail, which are transferred practically layer by layer in registers of automated control. At many points, this requires data captured by imaging technology, but not necessarily

728 Orit Halpern, Jesse LeCavalier, Nerea Calvillo, Wolfgang Pietsch, »›Test-Bed Urbanism,‹« *Public Culture* 25/2 (2013), 273–306, here: 291.

images in the sense of their materialization as directly viewable phenomena of iconic implementation. Ulrik Ekman has described this phenomenon as »ambient video«: »Paradoxically, ambient video indicates that ubicomp visuality is best seen without being seen.«[729] Already at the end of the 1980s, Paul Virilio conjectured (against the backdrop of what he saw as a looming »virtual« nuclear war of annihilation[730]) that »info-graphic software,« a computer-aided, numerical »visionics« without human eye-contact, without »videographic outputs« or »visual field« in the future will take on the »capacity to analyse the ambient environment and automatically interpret the meaning of events. [...] synthetic images created *by the machine for the machine*.«[731]

In fact: on one hand, images withdraw into ›ambientalized‹ processes of their automatic calculation, while on the other hand imaging technologies are increasingly employed as »logistical devices of tracking and orientation,«[732] as privileged providers of sensor input. The information that can be gathered from image data instrumentalized in such a way can obviously be detached from its circulation as visually transposed ›images of something.‹ For most sensor network images, generally speaking there are no longer observers but only transport plans, depots, and computers that read them according to their own standards and now often also operationalize them as training material for learning algorithms. These are thus images that are relevant and consequential—namely operational mediators for data treatment processes that can be variably connected—although they are not seen, but merely continually distributed, calculated, and analyzed.

While in Mark Weiser's vision of ambience the distribution between center and periphery was still expressly directed at human agents[733] who, in the

729 Ulrik Ekman, introduction to Ekman (ed.), *Throughout: Art and Culture Emerging with Ubiquitous Computing*, Cambridge, MA: MIT Press, 2012, 1–59, here: 3.

730 Paul Virilio, *The Vision Machine*, London: British Film Institute, 1994, 67ff. Cf. also Gabriele Schabacher, »Regime der Geschwindigkeit. Paul Virilios Verkehrstheorie,« in: Friedrich Balke, Maria Muhle (eds.), *Räume und Medien des Regierens*, Paderborn: Fink, 2016, 140–167, here in particular 154f.

731 Virilio, *The Vision Machine*, 59ff.

732 Peters, *The Marvelous Clouds*, 7.

733 The control that remains with human agents is interestingly explained by Weiser/Brown with reference to the »broader channels« of video streaming: »Continuous video from another place is no longer television, and no longer video-conferencing, but more like a window of awareness. A continuous video stream brings new details into the periphery: the room is cleaned up, something important may be about to happen; everyone got in later today on the east coast, must be a big snowstorm or traffic tie-up. Multicast shares with videoconferencing and television an increased opportunity to attune to additional details. Compared to a telephone or fax, the broader channel of full multimedia better projects the person through the wire. [...] Like the inner windows, Multicast enables

fluid movements of conscious shifts in attention, could (and should) decide what intelligent flows of information, individually »tuned« to single users, they wanted to be connected with situationally, it now appears that the »peripheral radius« contains ever larger zones that are fundamentally untransparent. The »decent signals,« which according to Weiser/Brown permeate the design-theoretical model of inner windows that connect as much as they shield, still reach human agents under the banner of ubicomp. But these windows have now been ›darkened‹ in the sense of blackboxing, thus making any informative view of the origin, composition, and calculation of the signal impossible, to a certain extent fundamentally so. The deeper they are embedded, the more remote the computer centers, the more complex the algorithmic processing, positioning, and addressing, the lower the probability that the »key property of information visualization«[734] facilitates an even superficial access to the processes of formatting this information. In this regard, sensor operations of visual capture, which often create the crucial input data for evaluating and directing the environment, but no longer create any graphically informative visualization, are only one particularly obvious example of computation-based processes of automation, which withdraw into the peripheries that are fundamentally inaccessible to the view of human users, if only because of their microtemporal structure.

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control of the periphery to remain with the individual not the environment« (Weiser, Brown, »The Coming Age of Calm Technology,« in: Peter J. Denning, Robert M. Metcalfe (eds.), *Beyond Calculation*, New York: Springer, 1997, 75–85, here: 78).

734 Ibid., 76. On the (diverging) relation between vision and visualization, Orit Halpern in *Beautiful Data* writes: »According to the OED, the term [visualization] is not ancient but rather a modern convention, only appearing in 1883 to depict the formation of mental images of things ›not actually present in sight.‹ Throughout the next few decades, this term expanded to encompass any ›action or processes of making visible.‹ Visualization slowly mutated from the description of human psychological processes to the larger terrain of rendering practices by machines, scientific instrumentation, and numeric measures. Most important, visualization came to define bringing that which is not already present into sight. Visualizations, according to current definition, make new relationships appear and produce new objects and spaces for action and speculation. While the language of vision perseveres, it is important not to assume a direct correlation between vision as a sense and visualization as an object and practice. Married initially to psychology, and now digital computation and algorithmic logic, the substrate and content of this practice has often had little to do with human sense perception or the content of this practice has often had little to do with human sense perception or the optic system. Moreover, with the rise of emphasis on haptic interactions and interactivity, visualizations also often take multisensorial modes. Vision cannot be taken, therefore, as an isolated form of perception, but rather must be understood as inseparable from other senses« (Halpern, *Beautiful Data*, 21).

The Internet of Things, which has emerged over various stages of development, nonetheless operates as a network that seems just as hard to imagine without the data acquisitions of image sensors as is a contemporary social media platform whose usage spectrum would refrain from positioning effortless image distribution on a massive scale as a central interface and practice option. While the visual culture associated with the second complex—whose image surfaces are dominated by memes, selfies, GIFs, by combined mixtures of newly captured and appropriated image components, by instant messaging services that are fungible in terms of image practices and countless photo and video sharing platforms—is only shielded with regard to the underlying data calculations of leading media firms, its exterior, constantly provided with new image content, is by no means ›calmed,‹ but rather characterized by forms of virally expanding visibility. Fed by the accelerated distribution practices of reproduction, modification, and communicative formatting of data images, a tendency seems to have become established that Michel de Certeau discussed as a symptom of the »consumer society« at the beginning of the 1980s and took as the occasion for »opaque,« dissident strolls that shirked general visibility and readability: »a cancerous growth of vision, measuring everything by its ability to show or be shown.«[735]

Independent of the semantics of cultural criticism, it is without doubt that the quantity of distributed image sensors is massively increasing, is being distributed throughout public, professional, and private spaces in ever denser gradations, and is now infiltrating all kinds of allegedly intelligent things well beyond smartphones with their multiple sensory capacities[736]: from drones and cars to tools, household appliances, and gadgets such as teddy bears that spy on small children. The capturing of the environment that emanates from this dissemination of sensors—capturing that should always be understood as relational and generative—brings infrastructural and logistical systems, nature reserves, dwellings, factory buildings, office towers, shopping centers, cities—and not least: human agents further ›self-quantifying‹ with wearable biometric sensors[737]—into increasingly more finely woven networks of their environmental datafication. Also due to the increasing capacities of

735 Michel de Certeau, *The Practice of Everyday Life*, Berkeley: University of California Press, 1984, xxi.

736 On the smartphone as a technological sensor device, cf. Andrejevic, Burdon, »Defining the Sensor Society«; Dourish, Bell, *Divining a Digital Future*, 40f., and Greenfield, *Radical Technologies*, 30ff.

737 Cf. Pablo Abend, Mathias Fuchs, Ramón Reichert, Annika Richterich, Karin Wenz (eds.), »Quantified Selves and Statistical Bodies,« Special issue, *Digital Culture & Society* 2/1 (2016).

optical resolution—both through comparatively secondary phenomena such as thermographic,[738] panoramic,[739] spherical[740] expansion processes of visual capture—image-based capture in »gigapixels«[741] becomes ever more fine-grained and gapless, which is likewise supported by standardized options for continuous real-time transmission, in the sense of a temporal expansion that now extends to NASA's 4K Ultra HD streams from outer space.[742] In short: more and more things are involved in translating more and more segments of the world into data images without interruption, allowing them to become constituted and operable as computerized environments. Making visible—»the growth of vision«—is aimed at controllability; imaging technology functions as a »full-fledged mediator« (Latour), with which environments are translated into data, linked up to data streams.

In this connection, therefore, the term ›distribution‹ indicates not least that in the context of various sensor networks, new agents of imaging technology and operational connections emerge, which become embedded into everyday fields of action—»the ordinary [is] the new frontier of computing«[743]—and precisely through allegedly non-invasive processes of automation, begin to latently influence these fields of action, which Kristin Veel, in a nod to Weiser's terminology, has called »calm imaging«: »[…] focusing in particular on images that are not addressing our conscious, focused attention, but that operate smoothly in the background. […] Images emerge and are received calmly as a matter of computational exchanges, but in the process they acquire new potentialities, qualities, and risks […].«[744] Accordingly, in the media-technological

738 Cf. Dylan Mulvin, Jonathan Sterne, »Media, Hot and Cold. Introduction: Temperature is a Media Problem,« *International Journal of Communication* 8 (2014), 2496–2503, and Lisa Parks, »Drones, Infrared Imagery, and Body Heat,« *International Journal of Communication* 8 (2014), 2518–2521.

739 Cf. Jay Bolter, Maria Engberg, and Blair MacIntyre, »Media Studies, Mobile Augmented Reality, and Interaction Design,« *Interactions* 20/1 (2013), 36–45, and Rothöhler, »Die zwölfte Fläche. Streaming, Mapping, Stitching Places.«

740 Cf. Elizabeth Woyke, »The 360-Degree Selfie,« *MIT Technology Review*, March 2017, https://www.technologyreview.com/technology/the-360-degree-selfie/.

741 An example of application: »CNN Takes You to The Inauguration of Donald Trump — See the Gigapixel« (in: https://edition.cnn.com/interactive/2017/01/politics/trump-inauguration-gigapixel).

742 Cf. Todd Spangler, »NASA, Amazon to Live-Stream First 4K Ultra HD Video from Space,« *Variety*, April 11, 2017, https://variety.com/2017/digital/news/nasa-amazon-first-4k-live-stream-space-1202028230/.

743 Greenfield, *Everyware*, 23.

744 Kristin Veel, »Calm Imaging: The Conquest of Overload and the Conditions of Attention,« in: Ulrik Ekman (ed.), *Throughout: Art and Culture Emerging with Ubiquitous Computing*, Cambridge, MA: MIT Press, 2012, 119–132, here: 120 and 123f.

ambience of environmental sensor capture, images circulate whose ›sedation‹ is connected with a divergent assessment of its status as data. As sensor data, images become signals that generally accrue directly to instrumental agendas of their computability, or are kept available in big data storage for later evaluation. From the viewpoint of the entities doing the processing, there is no need for visual phenomenalization in order to make the signals of visual capture productive. The applicable calculations recognize patterns in value tables formatted as raster graphics, in sets of numbers that in many cases are indeed encoded as images and can be displayed as such, but need not be in order to be effectively operationalized.[745]

While algorithmic access to image data in sensor networks is aimed at recognizing patterns, and thus bypasses perceivable image forms, with regard to recent developments in the field of so-called computational photography there are also experimental visual interpretations of this divergence of calculation and pictoriality.[746] Here, the data image does not become ›calm,‹ but more intense, invasive, and informative, with regard to its visualized exterior as well. For instance, highly detailed high-contrast images (high-dynamic range) emerge on the basis of an algorithmic fusion of distributed image sensor capturing processes, which are based, in the case of the advanced L16 camera by the manufacturer Light, on the »folded optics« of up to sixteen sensor acquisition units. The ›individual images‹ of these sensors, no longer captured sequentially, but simultaneously, are ›folded together‹ into image syntheses saturated with information, which leads to significantly higher resolutions and contrast ranges, and at the same time facilitates areas of sharpness that can be combined at will and options for shifting focus afterwards.[747] From this perspective, concretely materialized images contain numerous latent layers of additional information, which can be derived complementarily from the same data set as alternative visualizations.

A further performance boost in the integration calculus of image processing software—which by now has been positioned within the imaging pipeline so close to the moment of acquisition that it generates real-time effects—is currently expected above all from the plenoptical functions of so-called light field cameras.[748] Their smart optics operate fundamentally logistically: what is

745 Cf. Steven L. Tanimoto, *An Interdisciplinary Introduction to Image Processing. Pixels, Numbers, and Programs*, Cambridge, MA: MIT Press, 2012, 3–20.

746 Cf. Marc Levoy, »Experimental Platforms for Computational Photography,« *IEEE Computer Graphics and Applications* 30/5 (2010), 81–87.

747 Cf. Light, https://light.co/technology.

748 Cf. Ramesh Raskar, »Computational Photography: Epsilon to Coded Photography« [2009], in: F. Nielson (ed.), *Emerging Trends in Visual Computing. ETVC 2008. Lecture Notes in Computer Science*, Vol. 5416, 238–253, Berlin/Heidelberg: Springer, 2009.

captured is not simply light that falls on an image sensor, but also—via microlens arrays that produce various viewing angles on a scene framed as the field of view—information about the direction in which the light rays are traveling.[749] The algorithmic recalculation of each light transport route creates a light field whose image data, which contains information about spatial depth, can be variably implemented and, for instance, modelled in three dimensions. These light logistics, directly datafied in complex ways in the process of capture, thus create images whose concrete visibility can be described even more basically as a contingent information-technological achievement of interpreting fundamentally more comprehensive visual data: »Computational photography attempts to record a richer visual experience, captures information beyond just a simple set of pixels and makes the recorded scene representation far more machine readable.«[750] Behind data that have been rendered visually there is more comprehensive information storage that can be calculated in the form of fundamentally different image outputs—with different distributions of focus, different perspectives, etc. The light-logistical data can be packed into image forms that present very different phenomena and constitutively point to divergent redistribution options, which could be equally transportable and visually materializable on the same foundation of data.

Thus, like in sensor networks, the algorithmically encircled visual capture here only generates »intermediate data,«[751] no longer even relatively binding visual manifestations, such as continue to be standardized according to formats like JPEG in the relation between image file and image display. When Jennifer

749 There are solutions based on imaging technology in the works that capture visual data without lenses, without an optical system: »With cameras capturing light differently, a lens isn't necessarily needed anymore. Instead, visual data can be gathered by playing tricks with light, like forcing it through a microscopic grating or diffracting it through a glass sphere. […] The light passes through a glass sphere instead of a traditional lens, and it is diffracted into a cup of angled sensors. Because the camera knows exactly how light will pass through the sphere, it decodes and stitches the data from each sensor to make a complete image. […] A group at Rambus Labs is developing lensless image sensors. Instead of the traditional glass, a microscopic grating is placed over the sensor. Light spreads out as it passes through the grating, creating complex patterns on the sensor. The patterns are deliberately cast by the grating, so that the image can be instantly reconstructed by software. Why all the hassle? It's for an entire camera that's less than a millimeter thick. But what we think of as ›the picture‹ would be unrecognizable to the human eye« (Dave Gershgorn, »Photography Without a Lens? Future of Images May Lie in Data,« *New York Times*, December 23, 2015).

750 Ramesh Raskar, Jack Tumblin, Ankit Mohan, Amit Agrawal, Yuanzen Li, »Computational Photography,« *The Eurographics Association* (2007), 1–16, http://dx.doi.org/10.2312/egt.20071066, here: 2.

751 Levoy, »Experimental Platforms for Computational Photography,« 81.

Gabrys, drawing on Katherine Hayles, theorizes the preliminary redistribution of sensor perception capacities as ›distributed sensing,‹ she is aiming on the one hand at new materialities and modalities in which environments can be perceived and experienced.[752] Human and non-human agency is flexibly redistributed in various sensor networks, which constitutes individual environments in each case. But it is also significant here that networked sensors capable of computation not only give rise to alternative data acquisitions and modes of capture, but increasingly also to powerful algorithmic agencies of instrumental interpretation. Their calmness is an effect of a tendential dismantling of the margins for human intervention:

> With these formations of ubiquitous and embedded computing, Hayles suggests that sense is distributed within and automated throughout environments in ways that challenge human sense-making. Sensory processing is not directed through human sensing-subjects primarily but is instead located throughout automated sensing processes. As it is decoupled from human subjects, sensing as a process of making meaning, and of generating capacities to make sense and act on information, can occur beyond the realm of human intervention. Indeed, many of the cameras trained on environments are not connected up to human bodies or eyes, but rather work through image analytics to detect patterns and send alerts when significant change is detected. In this case, cameras-as-sensors could be seen to operate in ways that Hayles identifies: as seemingly autonomous agents that are recasting practices of sensing and interpretation.[753]

Human actors are thus decentered in sensor networks, not only as perceptive agents, but also with regard to the increasingly distributed processing of the perceptual data gathered by the sensors. But how is this operational redistribution between sensing and sense-making concretely expressed in applications that can already be found beyond development laboratories?

Against the backdrop of the vast growth of accessible image data storage, numerous providers seem to be focusing above all on modes of interpretive preselection. Thus in the field of security and surveillance technologies, extensive video intelligence has come into use, which subjects the masses of data acquired through image sensors to automatic analyses in order to render them

752 Cf. Gabrys, *Program Earth*, 63f.
753 Ibid., 65.

pragmatically manageable. The typical range of services offered by a provider like SeeQuestor aims first and foremost at increasing efficiency in terms of the economics of time, with an optimized searchability of extensive video data banks. From thousands of hours of video material, which might come for instance from a multicamera system installed by the police in a metro station, scenes that contain certain patterns of movement within the image can be filtered out, as well as a gallery of the faces captured in this material. If one of them is marked as a »person of interest,« SeeQuestor promises to automatically extract all scenes in which the facial recognition algorithms detect the same face. Similar assistive scanning operations aim to use »attributes of search,« which refers to sorting the galleries of faces according to criteria such as male/female, glasses/no glasses, etc.[754]

The boundaries between application areas are fluid. For instance, the California company IntelliVision, which specializes in video analytics and smart cameras, operates its range of products—divided into the market-driven categories of smart security, smart home, and smart retail—with interchangeable or expandable technological solutions. Motion detectors and facial recognition algorithms, which inform concerned homeowners about the activities of burglars and pets or open the garage door upon positive identification via a database comparison, come into contact here with video-analytical processes

754 Cf. https://www.seequestor.com. The interpretive processes can also be stored in and redistributed via the cloud, as the P-React project promises: »Existing surveillance solutions installed are often positioned incorrectly and generate poor image quality unsuitable for evidential purposes. Furthermore, disparate systems coupled with non-existent communication channels, make video exploitation by law enforcement agencies nearly impossible. Effective communication and coordination between police, retailers, private security and those operating transport and other infrastructure owners is key. The P-REACT project will design and develop a low cost surveillance platform that will ensure communication between key users with a focus on increasing the ability of on the ground police and security personnel to respond. The solution will encompass intelligent video and audio sensors to detect petty crime incidents, a cloud based monitoring, alert detection and storage platform. Low-cost intelligent sensors (image and audio) will be installed in small business‹ premises and Transport infrastructure locations. These intelligent sensors will be connected to the cloud-based Video Content Management System (VCMS), where reported incidents will be constantly monitored and responded to. An incident detected by sensors will initiate a work flow including alerting relevant Security Personnel and/or police with the relevant video and intelligence information ensuring the appropriate response. The solution will encourage community participation in the reporting of petty crime and as such will be designed to receive information (images, video) captured by mobile smart devices or unconnected surveillance systems« (»In a Nutshell,« P-REACT [website], http://p-react.eu/nutshell/).

that metrically evaluate the consumer flow in a shopping mall and translate consumer movement patterns into a heat map.[755]

The fact that over the past several years the optimization of identifying objects and persons has begun to influence developments in imaging technology as well, thus shifting it ›closer‹ to the capturing processes of sensors, can be seen, for instance, in the »Foveacam« of the Chinese provider Deepglint, named for the *fovea centralis*, the area of the eye in mammals that sees most sharply. Using a process called »Dynamic Instant Pixel Allocation,« this smart camera can automatically increase pixel density up to a hundred times in image segments in which, for example, a person or a distant license plate is detected. The possibility of a resolution zoom triggered by pattern recognition shifts the principle of relocating focus into the transmission form of a live stream and generally expands the field of vision that can be addressed and evaluated by sensors. On the one hand this is meant to expand the space encompassed within the technological gaze that can be compressed instantaneously and at high resolution when detecting a certain pattern. At the same time, the negative selection of uneventful video sequences is also automated.[756] The intelligence of such systems operates on the basis of monitoring as a streaming, continuous transmission, and is understood as a pragmatic counterweight to

755 Cf. https://www.intellivision.com. In one market study the consultant firm McKinsey recognizes the promising potential for growth in video-based IoT technologies in the field of retail analytics: »IoT applications usually offer more value when they incorporate video analytics, since the technology allows them to consider a wider range of inputs and make more sophisticated decisions. For instance, some typical IoT applications use beacons that transmit location data each time they connect with a consumer smartphone in a store. While this data can help retailers track the number of visitors, a video-analytics application would provide more detailed demographic information, such as the genders and ages of the shoppers. With their advanced image- processing capabilities, video-analytics applications can consider multiple visual inputs, some of which may be ambiguous and require careful processing. For instance, they can assess the demographics and behaviors of retail customers and turn this information into business insights that assist with product assortment and placement, potentially improving store efficiency, customer conversion, customer loyalty, and other metrics. […] The software algorithms in video-analytics applications are now capable of gathering and analyzing video footage from multiple sources, thereby generating more detailed insights. For example, surveillance applications can identify people based on physical characteristics from video feeds collected at multiple locations at different times. Similarly, retail applications can aggregate data from multiple video feeds to determine the shopping patterns characteristic of different demographic groups« (Vasanth Ganesan, Yubing Ji, Mark Patel, »Video meets the Internet of Things,« McKinsey & Company, Technology, Media & Telecommunications, https://www.mckinsey.com/industries/technology-media-and-telecommunications/our-insights/video-meets-the-internet-of-things).

756 Cf. http://www.deepglint.com:9003/fovea/en/m.

the proliferation of data collected by sensors; it is thus meant to help economize time and storage by identifying the image data that is instrumentally relevant from the viewpoint of application. From this perspective, the difference between conspicuous/inconspicuous, eventful/uneventful, which is also central for methods of crowd monitoring and of situational awareness in general, is already based on interpretive scripts in algorithmic form, which preselect the data detected by sensors for further ascription of meaning.

The evaluation of such streaming images by information technology occurs in order to distributively exclude the majority of them, precisely to avoid the need to distribute them further. Their status as unseen images, as sensor outtakes, is nonetheless temporary in many cases, insofar as they remain, at least in the medium term, in (almost always centralized) memory banks, which can be sorted through in other ways at a later point in time. As long as the remaining elements are not erased, they remain in temporary storage, in the ambience, forming sensor data archives that lead into the history of the environment, which are meant to be correlatively and predictively calculable even in distant futures:

> […] ›sensor society‹ thus refers not just to the proliferation of automated sensing devices across the landscape, but also to the associated logics that are characteristic of automated, mechanized sensing: always-on information capture, the associated avalanche of data, and the consequent tendency toward automated information processing and response. It also refers to the changing ways of thinking about and using information with which automated sensing is becoming associated: in particular the Janus-faced use of data for both prediction and information retrieval—that is, the related goals of modelling the future and reconstructing the past.[757]

While applications like Google's Cloud Video Intelligence use learning algorithms to work on opening image data memory banks for processes of ›full text search,‹ to automatically recognize and annotate the image content (»label detection«) or formal qualities (»shot change detection«),[758] sensor networks are increasingly dependent on real-time analytics. Their pragmatic

757 Andrejevic, Burdon, »Defining the Sensor Society,« 13f.

758 Cf. https://cloud.google.com/video-intelligence, and Fei-Fei Li, »Announcing Google Cloud Video Intelligence API, and more Cloud Machine Learning updates,« *Google Cloud Blog*, March 8, 2017. https://cloud.google.com/blog/products/gcp/announcing-google-cloud-video-intelligence-api-and-more-cloud-machine-learning-updates.

implementation is structuring an everyday world that involves more and more imaging technology. If a new letter carrier comes to your mailbox, an »unfamiliar face« is registered, although this can also happen if the recording device unwittingly encounters its own reflection.[759] If a database comparison determines that the correct face, authorized per data image, is standing in front of the door, it will be opened without the need for an observer to deal with the images continually produced by the home security system. If a smart camera recognizes that a certain suitcase is left unattended on a railway platform for a long period of time, a security alarm will be triggered as a precaution with no human assessment of the situation: »These images are not fixed representations of environments, but rather are temporal markers of visual sensing data within larger data sets [...].«[760] The intelligent evaluation of a video feed is meant to detect persons, objects, situations in real time—in certain surveillance systems even »in anticipation«[761]—and thus to make constant distinctions within the incoming image data that define what counts as a relevant

759 »To test the Nest Cam IQ, I set it up in the *Financial Time*'s San Francisco bureau a few weeks ago. Every morning I got alerts telling me when my colleagues arrived in the office and when our regular cleaner came in after we had all left for the night. If someone arrived that the camera had not seen before, the Nest app warned me about an ›unfamiliar face‹. If I knew the person, I could enter their name; next time Tom or Hannah appeared, it would tell me so by name. In a small household, this may not be particularly useful. But for a large family it could bring peace of mind that the kids all got home safely, for instance, or warn when a stranger appears unexpectedly. If you do not want to get a push notification for every single person's comings and goings, the app collects moments of activity into a timeline for review at a later date. Nest's face-recognition software was pretty accurate, if not 100 per cent reliable. It did not eliminate false positives altogether, although it reduced them to a handful a week. When placed in one location, propped up on a tripod, I realised that it was mistaking its own reflection in a meeting room's glass wall for a human head and shoulders. [...] Other new features that mark the Nest Cam IQ out over the original device include the ability to zoom in when you are viewing live footage, thanks to that 4K sensor. Its Supersight software means that the video pans and zooms to follow a person around the room, even though the camera itself does not physically move« (Tim Bradshaw, »Review: Nest's Sharp Upgrade to Home Security Camera,« *Financial Times*, July 14, 2017).

760 Gabrys, *Program Earth*, 69.

761 »Crucial to these emerging surveillance systems is a radically new politics of anticipatory seeing. For the overarching feature of the new, militarized, surveillance push, whether its ›targets‹ are located in Manhattan and Baghdad, London and Fallujah, is an attempt to build systems of technological vision in which computer code itself is, along with databases of real or imaged ›targets‹, delegated with the agency of tracking and identifying ›abnormal‹ ›targets‹ from the background ›normality‹ of a homeland or war-zone city. Crucial here is the adaptation of the commercial practices of ›data mining‹ or ›predictive analytics‹ where algorithms are developed to look for patterns in the swathes of captured data, identify or profile behaviours or characteristics deemed to be ›unusual‹ or

signal, what should remain in the working memory ready to be displayed, and what is judged to be noise, which can then be erased or transferred to more distant, less accessible storage.

The image circuits, managed quasi-autonomously by non-human actors, that emerge in this process—and the effects of the sorting capacities operationalized by them—have been described by Kristin Veel using the example of Smartgate, a security system installed in Australian airports that works with facial recognition software:

> [Smartgate] takes an image of a traveller's face and matches it with a digitized image stored in the traveller's ePassport. If the match is successful, the traveller is cleared through customs and immigration control. The technique obviously allows for fast processing of the increasing number of travellers in a globalized world. However, it is also likely to have a significant impact on travelling patterns and on what has been termed ›software-sorted societies‹. [...] In the case of software sorting, we are thus seeing an example of calm surveillance technologies, which are undeniably countering the risk of overload inherent in border controls, but which have a huge impact on people's lives and the structure of society. [...] The images involved in such digital identity systems are most often not taken by and not received by humans.[762]

The calmness of the sensor network images thus results from the expanded possibilities of evaluating them, discarding them or letting them circulate along an operational chain and finally translating them into decisional automatisms of a »computational exchange« (Veel) that can be connected to at will—all without seeing the images themselves. In this scenario, agency tends to be redistributed in favor of non-human image actors, which not only increasingly implement autonomous operations of visual capture—and thus, as Mark B.N. Hansen has explained on various occasions, develop an »environmental sensorium« constituted by sensor technology[763]—but also begin to draw their own or preprogrammed conclusions from the visual environmental data. In this, no active human contributions are necessary to either gather or process the data.

›abnormal‹, and search for ›target‹ people, transactions or flows deemed to have such characteristics« (Crang, Graham, »Sentient City,« 803).

762 Veel, »Calm Imaging,« 122.

763 Mark B.N. Hansen, »Medien des 21. Jahrhunderts, technisches Empfinden und unsere originäre Umweltbedingung,« in: Erich Hörl (ed.), *Die technologische Bedingung. Beiträge zur Beschreibung der technischen Welt*, Frankfurt am Main: Suhrkamp, 2011, 365–409.

For Hansen, the image sensor operations involved here can no longer be described as examining individual visual objects, because these are broken down—following the trajectory of videographic discretization—into imperceptible microtemporal processes: »What appears beneath the shards of this exploded image is the dynamic and constructive, microtemporal process of imaging or modulation that directly engages and synthesizes (contracts-dilates) time matter itself, without the assistance of the form of the image and prior to the operation of macroconscious perception.«[764] Conscious acts of perception, which relate to relatively stable sense units such as image content, are accordingly replaced by heterogeneous sensor information flows, which do also distribute information of a »sensory« nature, but no longer format it and scale it up »macroscopically«:

> For the first time in our history and (very likely) in the history of the universe, we find our long-standing and up to now well-nigh unquestionable privilege as the world's most complex sensing agents challenged, if not overthrown, by the massively replicable and ubiquitously propagating technical capacity for sensing introduced by our smart devices and technologies. Taken individually, these devices and technologies are of course vastly less complex—by many orders of magnitude—than human bodyminds; cumulatively, however, and with their capacity to operate almost entirely without interruption and across a vast range of scales, they have already begun to dwarf us in their ability to gather and generate sensory data.[765]

At least the suggestion of a qualitatively new range of ambient sensor data streams—which no longer need be output in forms that are viewable, readable to the senses in order to have an effect on human actors[766]—seems completely

764 Mark B.N. Hansen, »Ubiquitous Sensation: Toward an Atmospheric, Collective, and Microtemporal Model of Media,« in: Ulrik Ekman (ed.), *Throughout: Art and Culture Emerging with Ubiquitous Computing*, Cambridge, MA: MIT Press, 2012, 63–88, here: 67.

765 Hansen, *Feed-Forward*, 161. On this point Ulrik Ekman notes: »[Mark Hansen] delineates the sensory impact of ubicomp as a question of an expansion of the visible to include the imperceptible: a new correlation of media and sensation that occurs beneath the temporal frame definitive of both image and conscious perception. Hansen approaches the invisibility of ubicomp as the invocation of a microsensational address by the image in its technical expansion to include a periphery of imperceptible but objectively sensory informational flows« (Ekman, introduction to *Throughout*, 25f.).

766 Jennifer Gabrys attempts to analyze these effects using Foucault's late reference to an »environmentally based governance« (cf. Gabrys, *Program Earth*, 190). In *The Birth of Biopolitics*, a pertinent footnote to one of Foucault's last lectures reads: »On the horizon

plausible in view of automated processes in sensor networks that analytically search through image data and, when applicable, emit operational signals. In such findings, the diagnosed deprivileging of human agency emerges as the result of an expansion and optimization of media technology. On one hand, the permeation of the environment by sensor technology involves ever more sophisticated modes of its computerized controllability. On the other, automation leads the microtemporal rhythm and the logistics of the corresponding processes shrouded in the ambient background—which are meant to transport, calculate, master the ubiquitously collected environmental and behavioral data—to a reduction in perceptible, pragmatically accessible margins for intervention. Under these conditions, the redistribution of the image outlined here thus arises above all in connection with the increasing significance of visual actors that capture environmental data through sensors and algorithmically process it, without requiring that visual input be stabilized and displayed in the form of an image.

This general ›imagelessness‹ in applications of imaging technology—as has been shown: understood as the effect of a redistribution that defers phenomenal materializations of images in favor of image data that are automatically transported further[767]—is manifest somewhat more ambivalently in the application context of so-called Augmented Reality (AR). Here, image sensors likewise function as privileged input devices and mediators, but from the user perspective they simultaneously produce interfaces saturated with information that are still formatted as images. Thus in a relevant practical handbook we read: »Virtual objects are inserted into real scenes, made available

of this analysis we see [...] the image, idea, or theme-program of a society in which [...] action is brought to bear on the rules of the game rather than on the players, and finally in which there is an environmental type of intervention instead of the internal subjugation of individuals« (Michel Foucault, *The Birth of Biopolitics: Lectures at the Collège de France, 1978–1979*, Basingstoke, UK: Palgrave Macmillan, 2008, 259–60).

767 Aside from the positions of Claus Pias and Birgit Schneider cited above, we can also, following Wolfgang Hagen, speak more fundamentally—namely in an epistemological sense—of the »playful« imagelessness of digital images with regard to their immanent »iconoclasm« (Gottfried Boehm): »It is not therefore because of the hardware but rather because of the epistemology encapsulated in the hardware that my proposition is the following: There is no such thing as a digital image. Strictly speaking, this is not a question of digitalization. Digitalization only converts, what is given electronically. Like cybernetics in general, digitalization is equivalent to quantum mechanics. It comes into play after the chip has been exposed according to the chance results of quantum mechanical computability.« (Wolfgang Hagen, »There Is No Such Thing as a Digital Image: Some Media Epistemological Remarks on Weak Ontology« [paper presentation, »Calculating Images,« UCSB, Santa Barbara, CA, March 2005]).

by cameras, in real time, in such a way that they are positioned correctly in space and supplement the real image. The digital information melds with the user's environment; this allows for the user to receive and see the information that is currently important directly at the place where he needs it. […] The superimposition that occurs is context sensitive, that is, suitable to and derived from the observed object. The real field of vision of a customer, for instance, is expanded with information that is important to him in the form of superimposed product suggestions or illustrations.«[768]

In distinction to virtual reality (VR),[769] AR is an act of integration, which transports computer-generated information or additional objects (in the latter case, a »three-dimensional relation between real and virtual objects is generated«[770]) not into a synthetic environment, but into a ›reality,‹ which should be understood as a »real image« insofar as it appears live in a field of view captured by image sensors.[771] The spatial boundaries of such a live feed therefore correspond to the marginal processes of an image surface that is continuously placed into temporary storage and generated videographically, and, for instance in applications based on mobile handheld devices[772]

768 Anett Mehler-Bicher, Michael Reiß, *Augmented Reality: Theorie und Praxis*, Berlin: De Gruyter, 2011, 2.

769 Paul Milgram et al. have defined AR as a »mixed reality« continuum, in which the poles that lie outside this variable mixed ratio are designated as »real environment« and »virtual environment.« Cf. Paul Milgram, Haruo Takemura, Akira Utsumi, Fumio Kishino, »Augmented Reality: A Class of Displays on the Reality-Virtuality Continuum,« *Telemanipulator and Telepresence Technologies* 2351 (1994), 282–292.

770 Mehler-Bicher, Reiß, *Augmented Reality*, 6.

771 AR is usually, but not necessarily, based on acts of seeing: »[…] we do not consider AR […] to be limited to the sense of sight. AR can potentially apply to all senses, augmenting smell, touch and hearing as well. AR can also be used to augment or substitute users' missing senses by sensory substitution such as augmenting the sight of blind users or users with poor vision by the use of audio cues, or augmenting hearing for deaf users by the use of visual cues« (Julie Carmigniani, Borko Fuhrt, »Augmented Reality: An Overview,« in: Borko Fuhrt (ed.), *Handbook of Augmented Reality*, New York: Springer, 2011, 3–46, here: 3).

772 Greenfield sees AR as a distributed »interface technique« and describes the principle behind it as follows: »Bundle a camera, accelerometer/gyroscope, and display screen in a single networked handset, and what you have in your hands is something that can sustain at least a rudimentary augmentive overlay. Add GPS functionality and a high-resolution three-dimensional model of the world—either maintained onboard the device, or resident in the cloud—and a viewer can be offered location-specific information, registered with and mapped onto the surrounding environment. In essence, phone-based AR treats the handset like the transparent pane of a cockpit head-up display: you hold it before you, its forward-facing camera captures the field of view, and an overlay of information is applied on top of it. Turn, and the onscreen view turns with you, tracked (after

whose framing is movable, is provisional. Transmission and processing occur instantaneously, in the imperceptible, microtemporal rhythms of ›real time‹ imparted by media technology, but they are also connected to media-logistical storage processes: on the one hand, with databases in which the superimposed information—such as additional virtual objects—are deposited as data sets, and on the other hand with those data returns that are an integral component of delivery protocols, especially in commercial applications. For the AR interface image as well, which ostensibly is fully immersed in its liveness and transparency, there is what John Durham Peters has described as »a boom in data«: »In an online world every act leaves a trace, a record of some sort, and such documentation provides potent data to those who can access and read it.«[773]

The ›reality‹ that is visually implemented on these navigable data surfaces is indeed supplemented or crossfaded with virtual objects (particularly popular at the moment: furniture and measuring tapes[774]), but not, as in VR applications, completely switched off. In location-based AR games—from ARQuake (2000) to Pokémon Go (2016)—but also in assistance applications for medical technology, which simulate ›xray views,‹[775] or in AR applications for managing complex industrial facilities, the visual output (rendering) occurs with the goal of facilitating interactions in real time, which in many cases requires recognizing and tracking objects in the surrounding real space. Before a piece of information or a computer-graphic object can be included as an »expansion of reality« and rendered as an augmented live image in the field of view, trackable patterns must be recognized in this visual field (and as precisely as possible, as an aid for minimally invasive surgery): »Computer vision renders 3D virtual objects from the same viewpoint from which the images of the real scene are being taken by tracking cameras. […] fiducial markers, optical images, or interest points are detected in the camera images. Tracking can make use of feature detection, edge detection, or other image processing methods to interpret the camera images.«[776] Image sensors operate here as localizing pointing devices, and their (informationally expanded) image products are meant to be ›seen through,‹[777] as it were.

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a momentary stutter) by the grid of overlaid graphics. And those graphics can provide anything the network itself offers« (Greenfield, *Radical Technologies*, 159f.).

773 Peters, *The Marvelous Clouds*, 7.

774 Cf. Jason Tanz, »Apple Bets the Future of Augmented Reality Will Be on Your Phone,« *WIRED*, July 8, 2017, https://www.wired.com/story/arkit-augmented-reality/.

775 Mehler-Bicher, Reiß, *Augmented Reality*, 16.

776 Carmigniani, Fuhrt, »Augmented Reality,« 6.

777 Carmigniani/Fuhrt speak of a »video-see-through technique« (ibid., 10).

The AR image, created algorithmically and utilized as an interface, precisely does not retreat behind automated calculations, but becomes an open, location-aware, permanently visualized information storage unit, from which patterns can be extracted and added under real-time conditions: »[…] the once self-contained image, at most supplemented or anchored by textual information can now be overlaid or augmented with visual, textual or aural information individually tailored to the viewer's exact location and specification.«[778] Image sensors are thereby transformed in a certain sense into spatially distributed search engines, which search in the ›real‹ world for datafied contact points for displaying computer-generated flows of information, which in the recent past—for instance in view of real-time image recognition processes like Google's not-yet-market-ready »visual search app« Lens, which is intended to be integrated into the provider's virtual assistant—have already given cause to suspect that not only language assistant systems, but increasingly also cameras are in the process of replacing the keyboard: »Point your camera at a tree, and it'll tell you the variety. Snap a pic of the new restaurant on your block, and it'll pull up the menu and hours, even help you book a reservation. Perhaps the single most effective demonstration of the technology was also its dullest—focus the lens on a router's SKU and password, and Google's image recognition will scan the information, pass it along to your Android phone, and automatically log you into the network. This simplicity is a big deal. No longer does finding information require typing into a search box. Suddenly the world, in all its complexity, can be understood just by aiming your camera at something.«[779] Google's Lens answers W.J.T. Mitchell's question from the beginning of this study—»What Do Pictures Want?«—with the automatically imported, connectivity-producing image of a router password, thus fairly unambiguously: digital images want to be on the net, to become connectable, distributable.

In its augmented version, the distributed image is nonetheless not ›calm‹—as it at least tends to be in sensor networks—but a visually ›enriched‹ presentation of data, which still conveys traditional photographic conventions on the surface, but at the same time is operable as an interface for deep layers of information technology. The instantaneously processed datagrams of visual capture flow into computer centers controlled by algorithms, which (temporarily) store the incoming data packets and respond with applicable storage holdings—with no temporal delay and precisely tailored—which leads

778 Kember, »Ambient Intelligent Photography,« 57.

779 Liz Stinson, »Your Camera Wants to Kill the Keyboard,« *WIRED*, May 22, 2017, https://www.wired.com/2017/05/camera-wants-kill-keyboard/.

to further requests, new calculations, horizons of continuing distribution. Imaging technology operates within the infrastructures and protocols of this environmental data traffic model as a mediator that supplies and processes the »machinic access to the data of sensibility«[780] in order to feed environments captured by sensors as a field of vision through dynamic filters of continuous pattern recognition. The distributed image thus follows a logistical mandate, even here. It exists as a process in the viewfinder, circulates in sensor networks, deposits datafied percepts, and creates informational transport connections.

780 Hansen, *Feed-Forward*, 53.

Postscript

Image data that circulate in the ambience follow transport calculations that are only secondarily interested in delivering image forms. The more efficiently these calculations operate, the less remains for human actors to do in terms of observing and processing images. Their discretion to act is thus, on the one hand, limited by the logistical scripts of non-distribution of visibility in image form, but on the other hand it is conserved for other things. The increasingly standardized ›calming‹ of the distributed image in sensor networks through computerized processes of automatic scanning cannot, however, be transferred without further ado as a generalizable principle into other application contexts of proliferative image data circulation—at least not yet—as illustrated by a streaming video from the platform Field of Vision, which specializes in »visual journalism« and belongs to eBay founder Pierre Omidyar's media company First Look Media.

In The Moderators,[781] the algorithmic channeling of the global flow of images encounters the precarious socio-economic distributive reality of human imaging work. »You have to judge data«—with this sentence a trainer standing in front of a group of young Indians (with only one woman among them) summarizes the job requirements of a »content moderator.« As is revealed in the course of the training week, documented here on film, the data in need of judgment include primarily digital images that are distributed in mass quantities via the interfaces of social media platforms, but should neither remain there nor be distributed further. The moderators-to-be are prepared for the script-based purgation of transmission channels ›flooded‹ with image data by means of casuistic exercises. The practical form of the »Human Intelligence Tasks« (HIT) to be performed here turns out to be filter factory work. At one point there is mention of 2,000 images per hour that roll past on the assembly line monitor of an individual moderator—who is to check them for content classified as »inappropriate« in the regulations (which differ in their details) of providers not identified by name.[782] Along with deleting fake profiles, which present a significant problem especially for commercial dating sites, this work

781 The Moderators (Adrian Chen/Ciaran Cassidy, 2017), https://fieldofvision.org/the-moderators.

782 The Facebook Manuals were recently leaked; cf. Olivia Solon, »Underpaid and Overburdened: The Life of a Facebook Moderator,« *Guardian*, May 25, 2017.

on the image, performed largely out of sight, is first and foremost concerned with detecting and excising »extreme imagery.«[783]

As Susan Leigh Star and Anselm Strauss have remarked on the question of the (relative) visibility of work in general: »[…] work does not [disappear] with technological aids. Rather, it is displaced—sometimes to the machine, but just as often to other workers. To the extent that the work of some people is ignored while they are perceived as non-persons, more ›shadow work‹ or invisible work is generated—along with (sometimes) obvious questions of societal justice and inequality. In the configuration of large-scale networked systems, this process can cascade.«[784] The reason that this repetitive, psychically onerous image work—invisibilized as »microwork« in platform capitalism and accordingly poorly compensated—cannot be delegated, is justified in THE MODERATORS with technological skepticism: »You can't be dependent on automation in this thing. Without humans it's not possible, for now at least.«

In the digital present, ubiquitous imaging technologies that can be activated with little effort and transmitted in real time are not only fueling the proliferation and differentiation of sensor networks, but also continue to feed the excesses of image distribution on social media. The visual culture modulated in this way is obviously anything but ›calm.‹ Even if it is not intended to diffuse completely unfiltered, its economic calculus is still aimed at unbridled growth, at a logic of escalated distribution and replication at will: more users, more profiles, more images, more ads—bigger and bigger data that can be aggregated, distributed further, explored, and managed. As THE MODERATORS presents paradigmatically, between the production and the usage of distributed digital images—that is, in the primary purview of logistics—there is still an astonishingly large amount of human work that handles image data as images and is targeted at erasing the information they contain.

This human image work is also distributed—according to the guidelines of a calculation distributed in the global economy: from acquiring raw materials, which is accomplished for example in Congolese cobalt mines, in order to be able to supply smartphones—and their versatile imaging technology—with cheap lithium-ion batteries,[785] to ›manual‹ channel filtering, which responds

783 Ibid.

784 Susan Leigh Star, Anselm Strauss, »Schichten des Schweigens, Arenen der Stimme. Die Ökologie sichtbarer und unsichtbarer Arbeit« [1999], in: Susan Leigh Star, *Grenzobjekte und Medienforschung*, ed. Sebastian Gießmann and Nadine Taha, Bielefeld: Transcript, 2017, 287–312, here: 300.

785 In 2016 Amnesty International published a detailed report on the conditions involved in this work: »Human Rights Abuses in the Democratic Republic of the Congo Power the Global Trade in Cobalt,« Amnesty International, January 15, 2016, https://

to the unfettered image productivity of the digital gadgets produced in this way with perceptual contract work. There are overarching, structural economic asymmetries within the ›world system‹ that lead to moderators from the Indian underclass first having to learn what an American media company like Facebook considers »nudity,« and then serially implement this knowledge in image assessment practices. Ayhan Aytes, who sees HIT in general as »cognitive work« and has discussed it critically using the paradigmatic case of Amazon's Mechanical Turk—»the digital network is the assembly line of cognitive labor«[786]—remarks on the distributional reality of largely unregulated crowd work: »[…] this sociotechnical system represents a crucial formation on a global scale as it facilitates the supply of cognitive labor needs to mainly Western information and communication technologies industries from a global workforce.«[787]

Thus far the situation has not really reached the point of an open declaration of »world war between algorithms and raw materials,«[788] which Friedrich Kittler sought to bring into the field of media studies nearly twenty years ago, but without going into greater detail. What was the concern again, nearly twenty years ago? Cold War, NSA, missile officers in Peenemünde, Leonard Cohen's »Bunch of Lonesome Heroes,« or maybe back to silicon again after all? The fact that »the South of this planet« loses out with regard to »the at least two-hundred-year-old problem of information versus energy, algorithms versus raw materials«[789] only continues, with no metaphorical detours, in relation to the distribution of digital image work. At least the problem of »moderating hubs around the world« has by now entered into public discourse, even if only sporadically.[790] Even in parts of media studies—which first discovered, with Susan Leigh Star's work, the invisible work of maintaining (and situationally adapting) infrastructures[791] and has recently begun to turn its attention to the logistical ›groundwork‹ in data centers or on ships that sail on maintenance

www.amnestyusa.org/reports/this-is-what-we-die-for-human-rights-abuses-in-the-democratic-republic-of-the-congo-power-the-global-trade-in-cobalt/.

786 Aytes, »Return of the Crowds,« 94.

787 Ibid., 80.

788 Kittler, *Optische Medien*, 300.

789 Ibid., 299. On the relationship between information and energy in Marx, Simondon, and others, cf. Matteo Pasquinelli, »Der italienische Operaismo und die Informationsmaschine,« in: Ramón Reichert (ed.), *Big Data. Analysen zum digitalen Wandel von Wissen, Macht, Ökonomie*, Bielefeld: Transcript, 2014, 313–332.

790 Nick Hopkins, »Facebook Moderators: A Quick Guide to Their Job and Its Challenges,« *Guardian*, May 21, 2017.

791 Susan Leigh Star, »Die Ethnografie von Infrastruktur« [1999], in: *Grenzobjekte und Medienforschung*, 419–436. Cf. also Sebastian Gießmann, Nadine Taha, »›Study the

assignments along fiber optic cable routes[792]—there is a growing interest in the »social question«[793] of an oligopolistic data and platform economy that maintains a sub-proletariat in the countries of the Global South, which performs monotonous work along whatever are the current boundaries of algorithmic capacities[794]—in terms of technology as well as economic rationalization.[795] This reveals a structural level of the digital divide that cannot be understood solely through questions of network connectivity or exclusion and enables Western media companies to outsource the remaining human data processing work that is still necessary for the lowest wages possible, until, in the vision of a proximate future that is perhaps not at all so free of ambivalence, processes of non-human storage readings ultimately channel the streams autonomously through information technology.

The click farms, the hubs of the Global South that employ moderators or »ads quality raters,« where the global emergence of images actually passes through not as an abstract mass of numbers, but in enormous volumes of materialized image forms, in fact also produce data packets that are meant to ›rationalize‹ this filtering process in a logistically different way. Human gazes not only work in these hubs to remove objectionable, illegitimate, or otherwise ›inappropriate‹ images from visible traffic, but also to select training data suitably compiled for those learning algorithms that ought to make it possible to largely delegate these practices of image assessment to non-human actors in the medium term.[796] If and when it is profitable to do so.

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unstudied‹. Zur medienwissenschaftlichen Aktualität von Susan Leigh Stars Denken,« in: ibid., 13–80.

792 Cf. Rossiter, *Software, Infrastructure, Labor*, and Starosielski, *Undersea Network*.

793 Monika Dommann, »Algorithmus und Arbeit,« *Cargo Film/Medien/Kultur* 35 (2017), 66–69.

794 Cf. Nick Deyer-Whiteford, *Cyber-Proletariat. Global Labour and the Digital Vortex*, London: Pluto Press, 2015; Fuchs, *Digital Labour and Karl Marx*; Trebor Scholz, *Uberworked and Underpaid. How Workers Are Disrupting the Digital Economy*, Cambridge, UK: Polity Press, 2016; Scholz, *Digital Labor*; Scholz, Laura Y. Liu, *From Mobile Playgrounds to Sweatshop City* (*Situated Technologies Pamphlets 7*), The Architectural League of New York, 2010.

795 On the economic logic of Amazon's Mechanical Turk, Thomas Waitz remarks: »As an example of such an ›HIT,‹ for instance, Amazon presents the production of audio transcripts; in fact, typical activities tend rather to be evaluating masses of user comments […] or tagging images. It is by no means a matter of tasks that computers are ›not yet‹ capable of performing. Often it is simply cheaper to have people deal with certain tasks than to introduce automation software, which must first be developed and tested« (Thomas Waitz, »Gig-Economy, unsichtbare Arbeit und Plattformkapitalismus,« *Zeitschrift für Medienwissenschaft* 16 (2017), 178–183, here: 182).

796 Cf. Davey Alba, »The Hidden Laborers Training AI to Keep Ads Off Hateful YouTube Videos,« *WIRED*, April 21, 2017, https://www.wired.com/2017/04/zerochaos-google-ads-

The idea that the desire for the image as image would thus be erased, that the information waiting in image archives to be extracted from image forms and transported into discourses would become completely meaningless, nonetheless seems rather far-fetched. Either way, the digital image, its transport calculations, its readability, remains: a question of distribution.

quality-raters/, and Annalee Newitz, »The Secret Lives of Google Raters,« Ars Technica, April 27, 2017, https://arstechnica.com/features/2017/04/the-secret-lives-of-google-raters/.

Figures

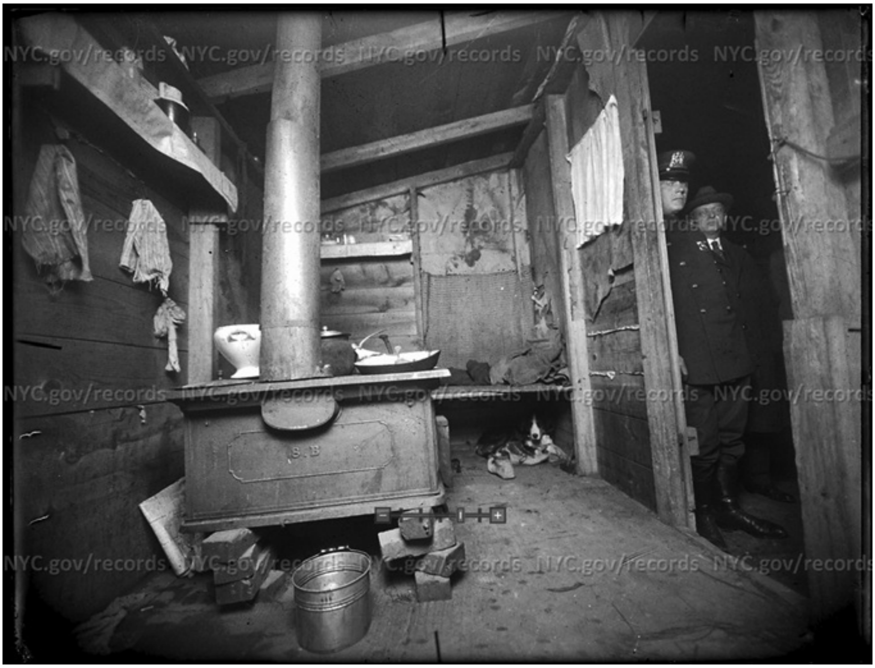


Fig. 1 *pd_0238* (New York City Department of Records)

Fig. 2 *pd_0238* (New York City Department of Records)

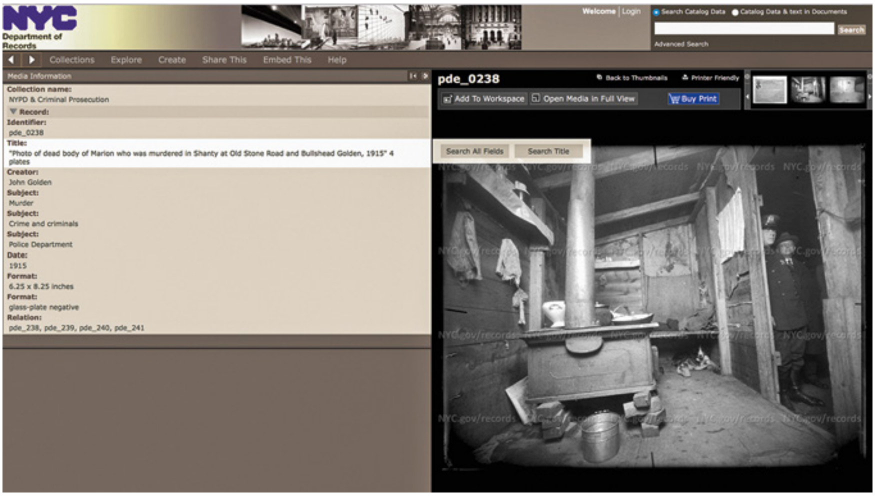


Fig. 3 *pd_0238* (New York City Department of Records)

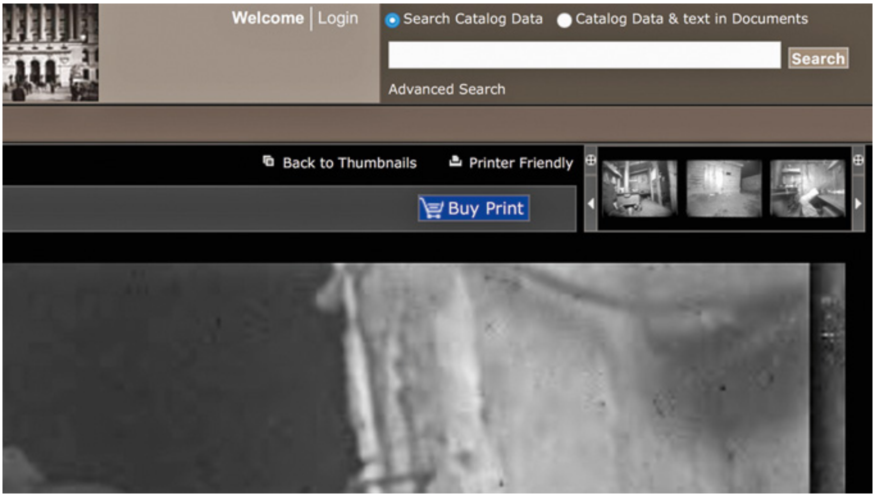


Fig. 4 *pd_0238* (New York City Department of Records)

Fig. 5 *pd_0240* (New York City Department of Records)

Fig. 6 *pd_0241* (New York City Department of Records)

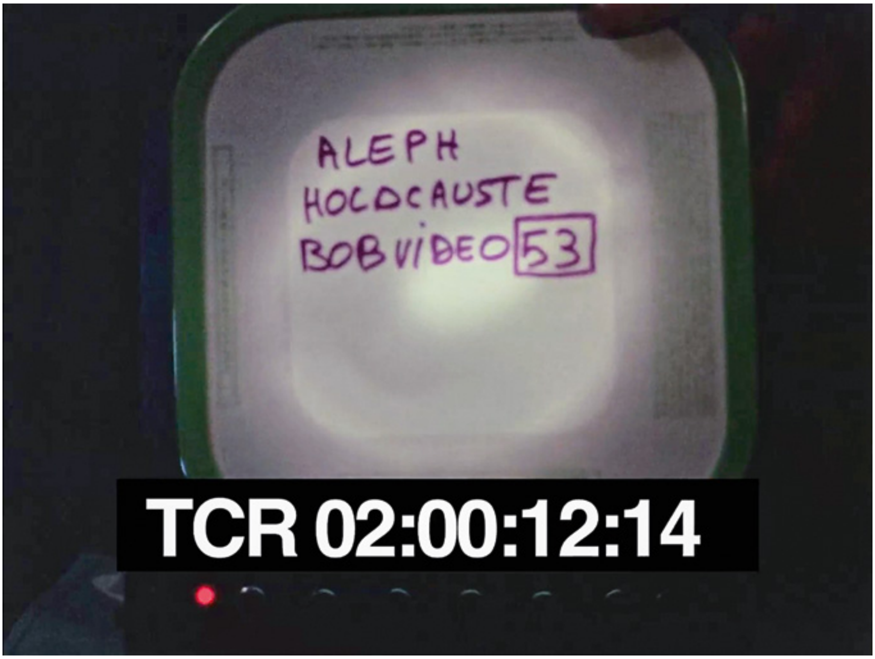


Fig. 7 *Film ID 3437* (United States Holocaust Memorial Museum)

Fig. 8 *Film ID 3437* (United States Holocaust Memorial Museum)

Fig. 9 *Film ID* 3437 (United States Holocaust Memorial Museum)

Fig. 10 *Film ID* 3437 (United States Holocaust Memorial Museum)

Fig. 11 *Film ID 3293* (United States Holocaust Memorial Museum)

Fig. 12 *Film ID 3293* (United States Holocaust Memorial Museum)

Fig. 13 *Film ID 3293* (United States Holocaust Memorial Museum)

Fig. 14 *Film ID 3293* (United States Holocaust Memorial Museum)

Fig. 15 *Film ID 3440* (United States Holocaust Memorial Museum)

Fig. 16 *Film ID 3247* (United States Holocaust Memorial Museum)

Fig. 17 *Film ID 3247* (United States Holocaust Memorial Museum)

Fig. 18 *Film ID 3247* (United States Holocaust Memorial Museum)

Fig. 19 *Film ID 3247* (United States Holocaust Memorial Museum)

Fig. 20 *Film ID 3437* (United States Holocaust Memorial Museum)

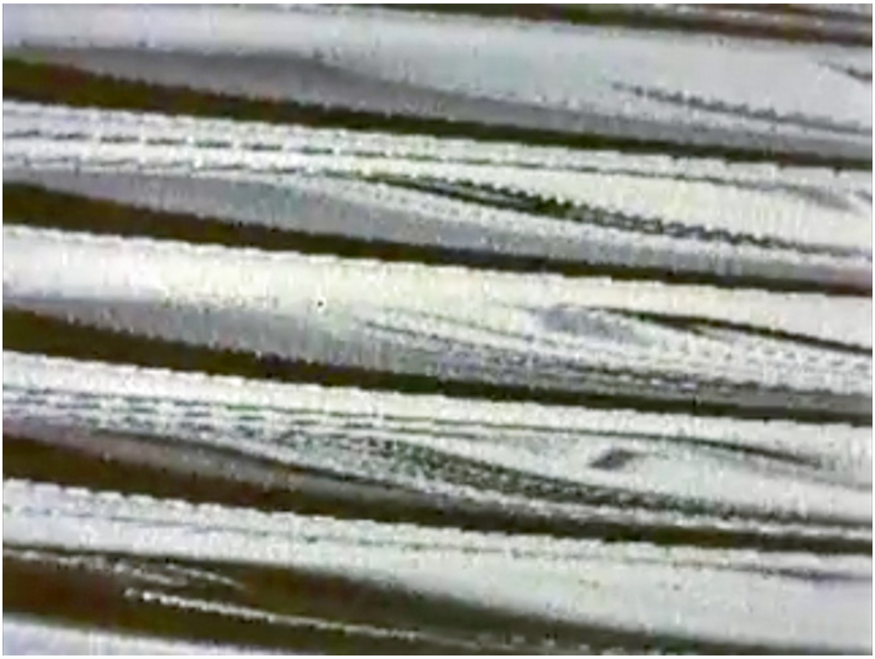


Fig. 21 *Film ID 3216* (United States Holocaust Memorial Museum)

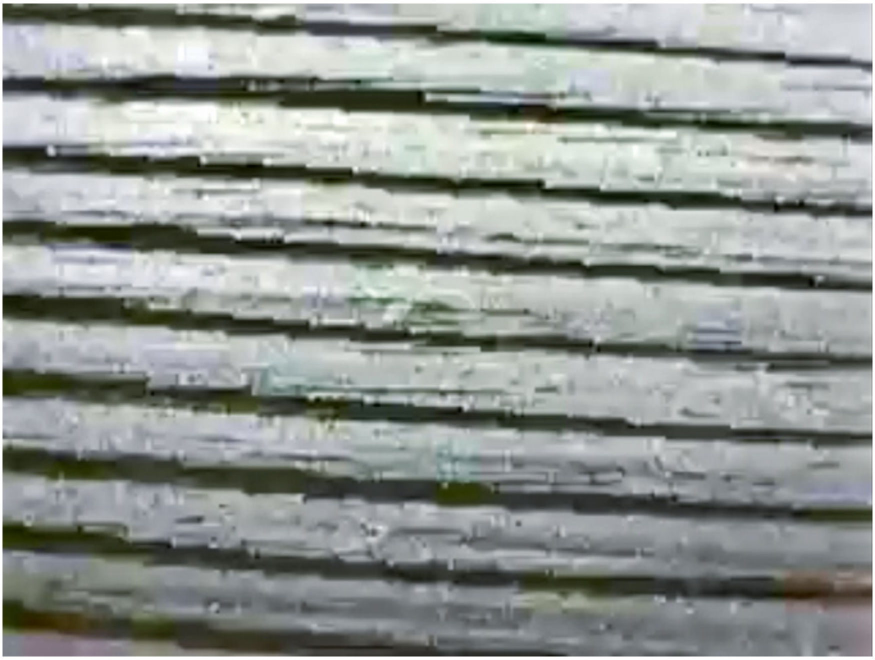
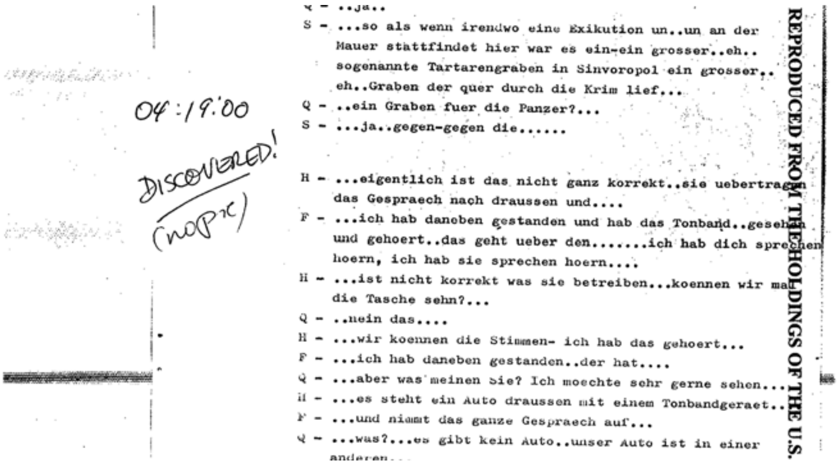


Fig. 22 *Film ID 3216* (United States Holocaust Memorial Museum)

Fig. 23 *Film ID 3216* (United States Holocaust Memorial Museum)

Fig. 24 *Film ID 3216* (United States Holocaust Memorial Museum)

Fig. 25 *Film ID 3437* (United States Holocaust Memorial Museum)



04:19:00
DISCOVERED!
(no pic)

Q – ..ja..
S – ...so als wenn irendwo eine Exikution un..un an der Mauer stattfindet hier war es ein-ein grosser..eh.. sogenannte Tartarengraben in Sinvoropol ein grosser.. eh..Graben der quer durch die Krim lief...
Q – ..ein Graben fuer die Panzer?...
S – ...ja..gegen-gegen die......

H – ...eigentlich ist das nicht ganz korrekt..sie uebertragen das Gespraech nach draussen und....
F – ...ich hab daneben gestanden und hab das Tonband..gesehen und gehoert..das geht ueber den.......ich hab dich sprechen hoern, ich hab sie sprechen hoern....
H – ...ist nicht korrekt was sie betreiben...koennen wir mal die Tasche sehn?...
Q – ..nein das....
H – ...wir koennen die Stimmen- ich hab das gehoert...
F – ...ich hab daneben gestanden..der hat....
Q – ...aber was meinen Sie? Ich moechte sehr gerne sehen...
H – ...es steht ein Auto draussen mit einem Tonbandgeraet..
F – ...und nimmt das ganze Gespraech auf...
Q – ...was?...es gibt kein Auto..unser Auto ist in einer anderen...

Fig. 26 *RG 60.5013* (United States Holocaust Memorial Museum)

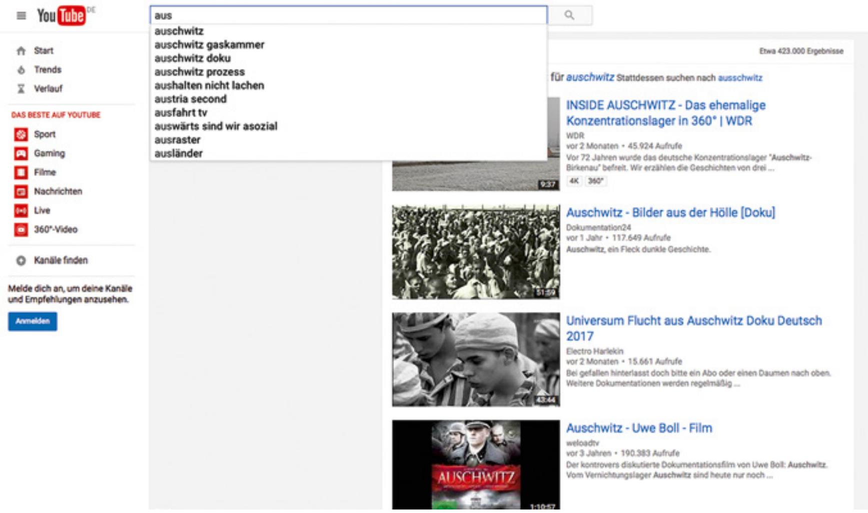


Fig. 27 *You Tube (youtube.com)*

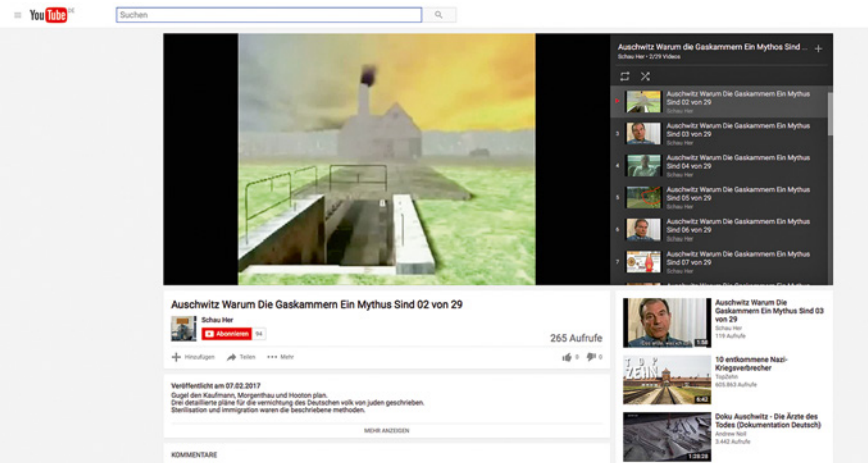


Fig. 28 *You Tube (youtube.com)*

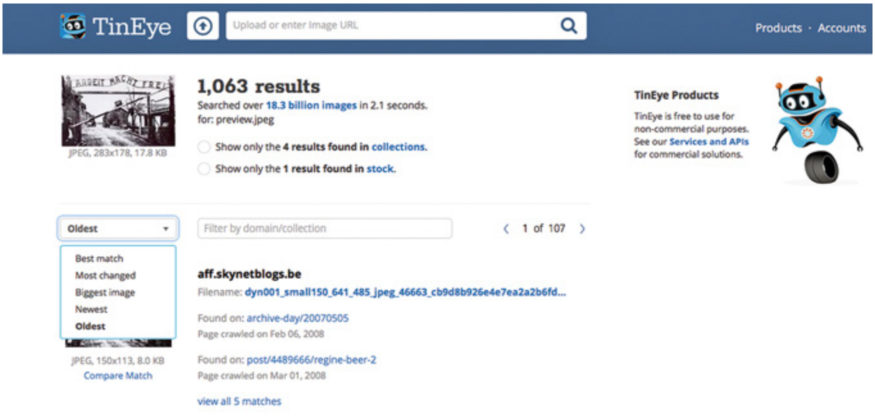


Fig. 29 *TinEye Reverse Image Search* (*tineye.com*)

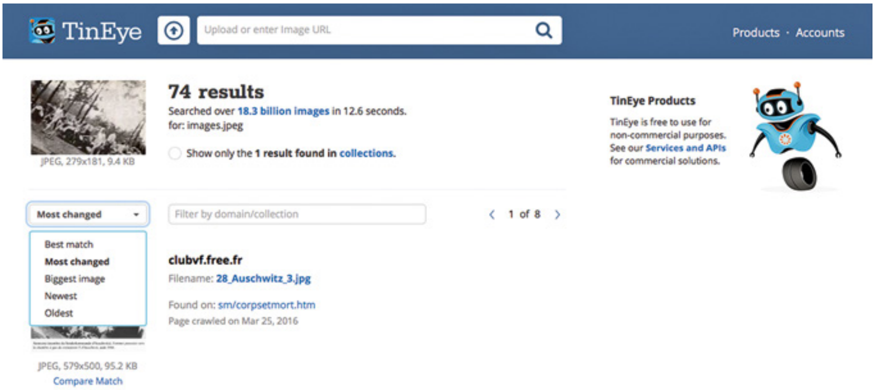


Fig. 30 *TinEye Reverse Image Search* (*tineye.com*)

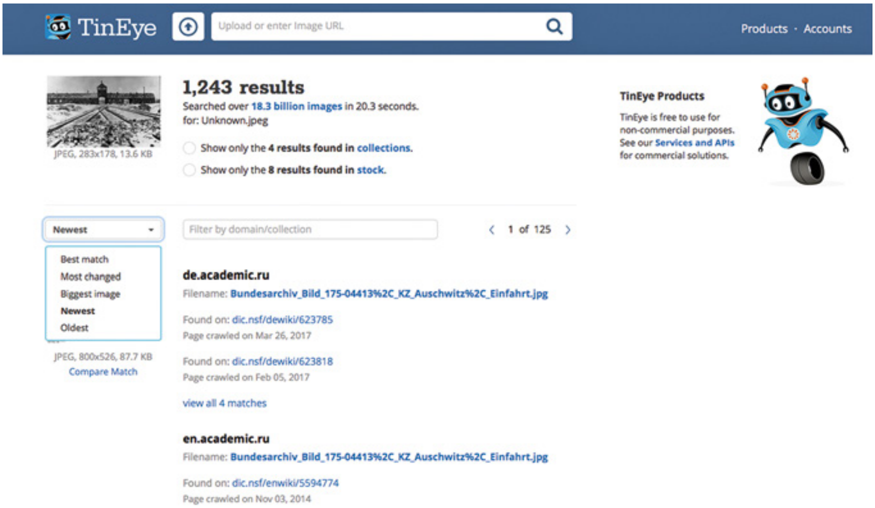


Fig. 31 *TinEye Reverse Image Search* (*tineye.com*)

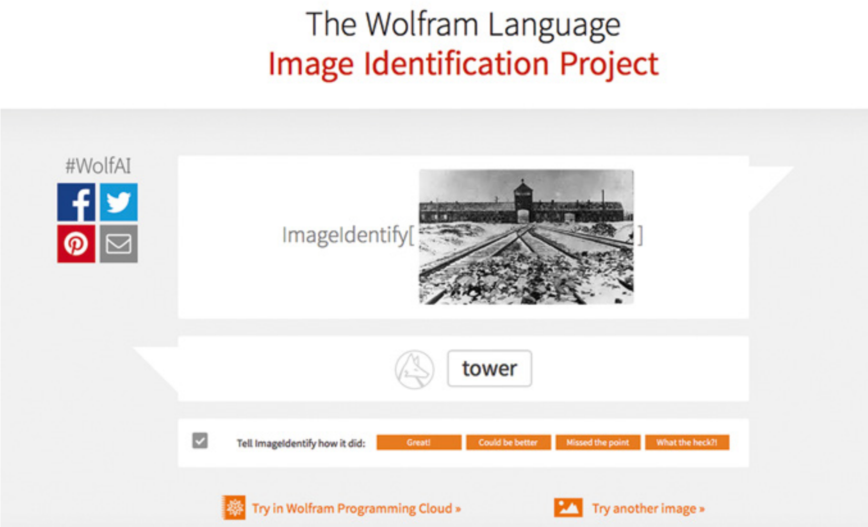


Fig. 32 *The Wolfram Language Image Identification Project* (*imageidentify.com*)

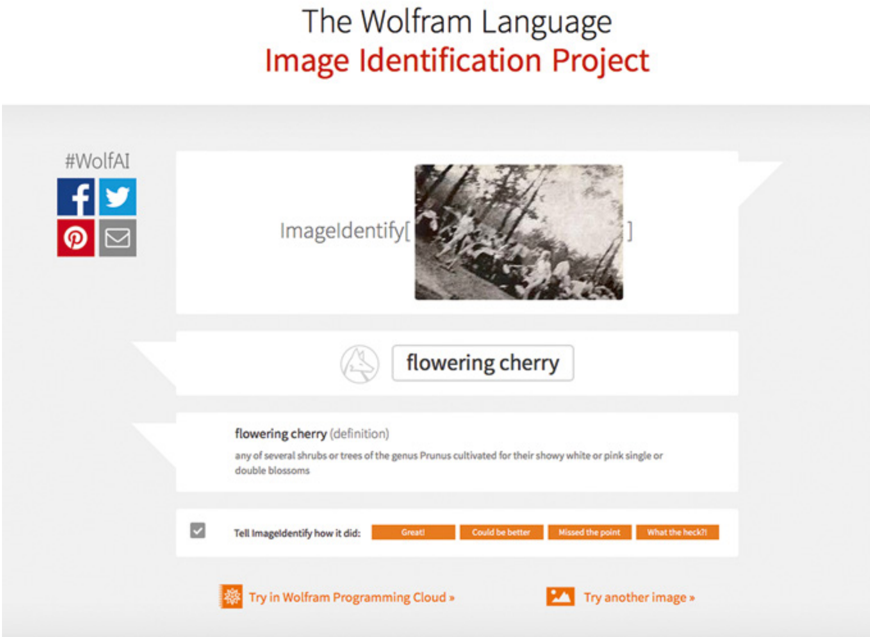


Fig. 33 *The Wolfram Language Image Identification Project* (*imageidentify.com*)

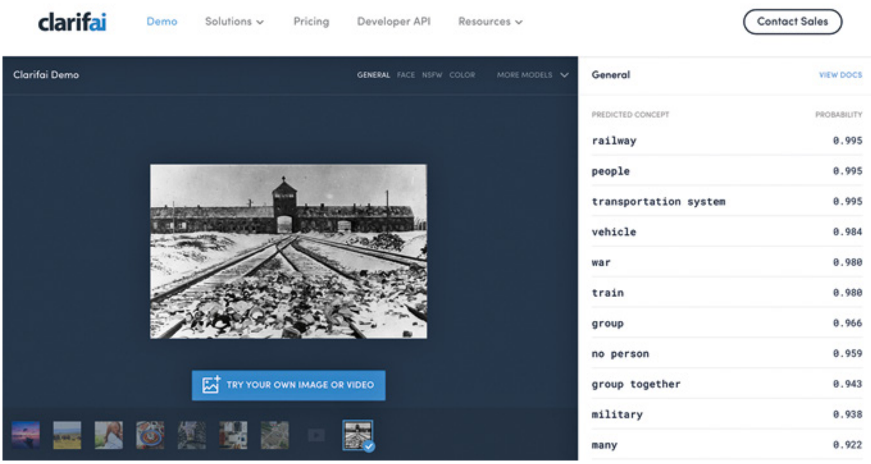


Fig. 34 *Clarifai | Image & Video Recognition API* (*clarifai.com*)

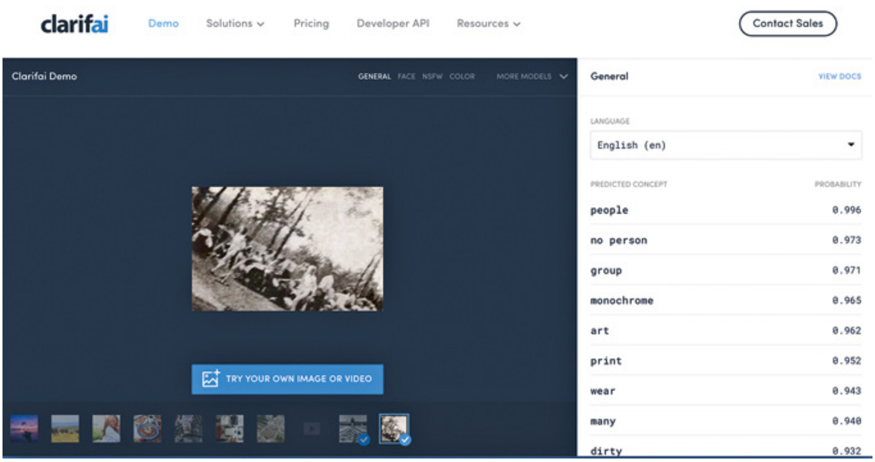


Fig. 35 *Clarifai | Image & Video Recognition API* (*clarifai.com*)

Fig. 36 *Forensic Department Central Photo Technology State Criminal Police Office, Bavaria*

Fig. 37 *Forensic Department Central Photo Technology State Criminal Police Office, Bavaria*

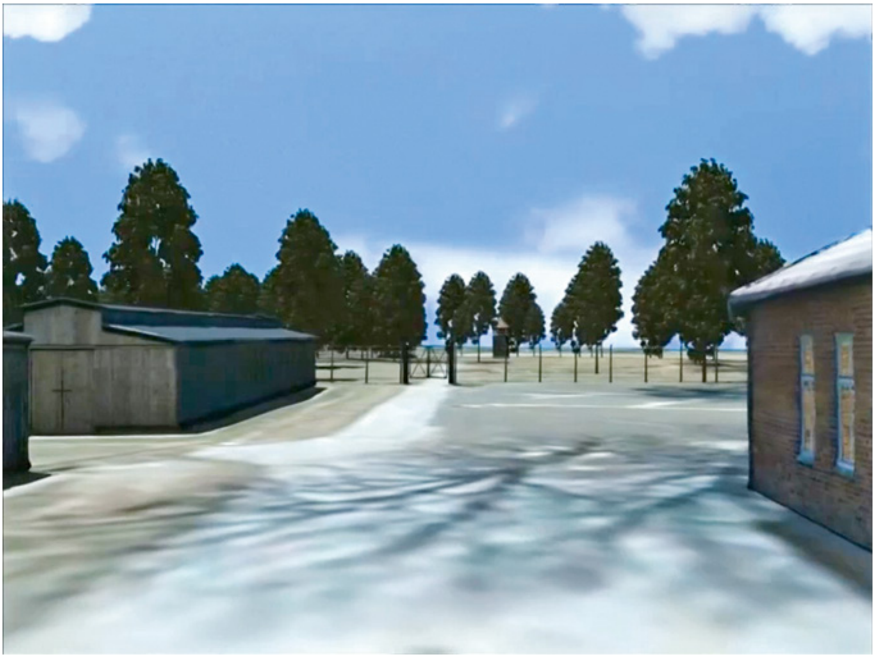


Fig. 38 *Forensic Department Central Photo Technology State Criminal Police Office, Bavaria*

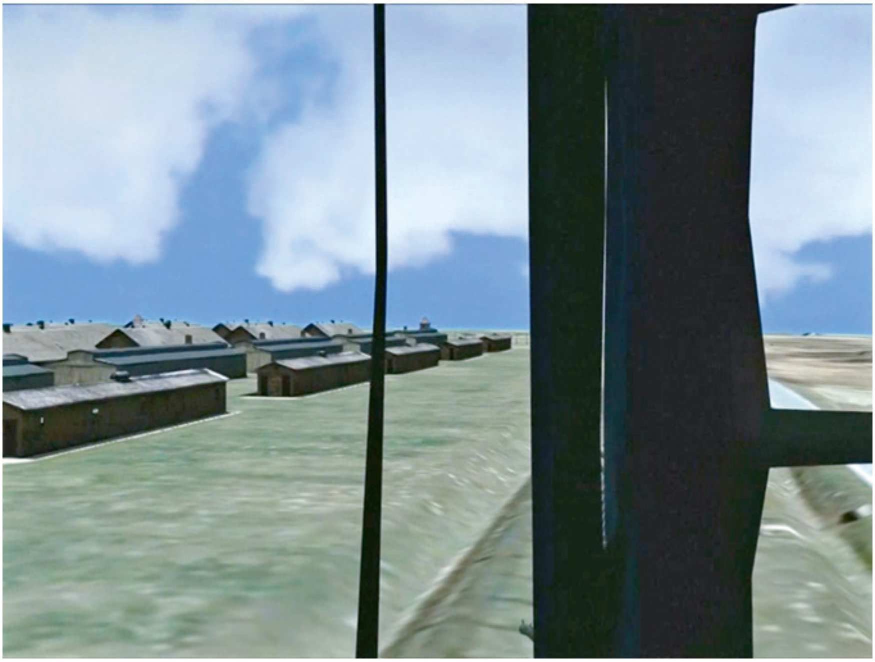


Fig. 39 *Forensic Department Central Photo Technology State Criminal Police Office, Bavaria*

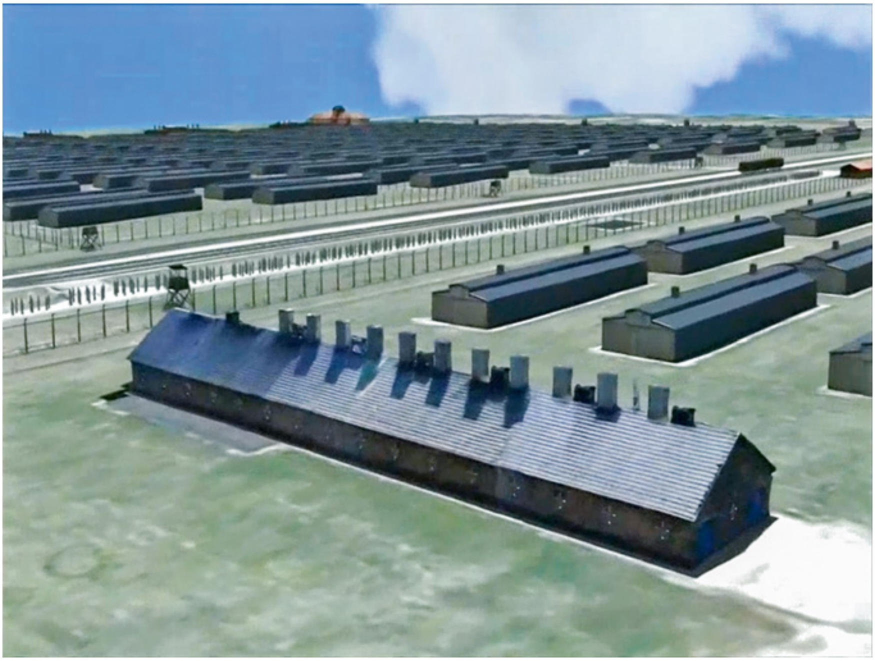


Fig. 40 *Forensic Department Central Photo Technology State Criminal Police Office, Bavaria*

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