# Images on the Move: Materiality - Networks - Formats

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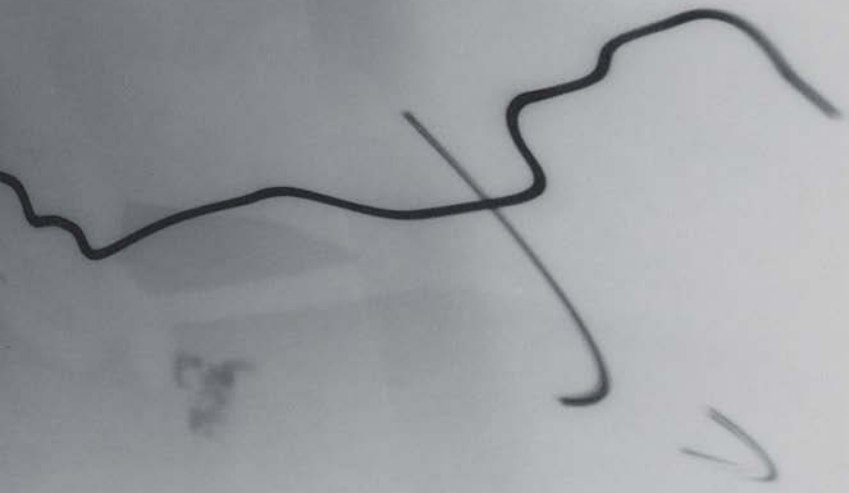
# IMAGES ON THE MOVE

## MATERIALITY—NETWORKS—FORMATS



[transcript] Media Studies

Olga Moskatova (ed.)
Images on the Move

**Media Studies** | Volume 76

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Materiality—Networks—Formats

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This book was funded by the Dr. German Schweiger-Stiftung and the Universitätsbund Erlangen-Nürnberg.

**Bibliographic information published by the Deutsche Nationalbibliothek**
The Deutsche Nationalbibliothek lists this publication in the Deutsche Nationalbibliografie; detailed bibliographic data are available in the Internet at http://dnb.d-nb.de




**First published in 2021 by transcript Verlag, Bielefeld**


Cover layout: Maria Arndt, Bielefeld
Cover illustration: Thomas Bachler, *From Düsseldorf to Kassel*, from the series *Reiseerinnerungen (Souvenirs)*, 1985 black and white paper negative; 8 1/16 x 11 3/16 in. (20,5 x 28,4 cm) San Francisco Museum of Modern Art, Accessions Committee Fund purchase © Thomas Bachler, photo: Don Ross
Proofread by Dr. Lucinda Rennison
Printed by Majuskel Medienproduktion GmbH, Wetzlar
Print-ISBN 978-3-8376-5246-8
PDF-ISBN 978-3-8394-5246-2
https://doi.org/10.14361/9783839452462
ISSN of series: 2569-2240
eISSN of series: 2702-8984

Printed on permanent acid-free text paper.

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## Trajectories and Traces

# 1. Introduction: Trajectories of Images

*Olga Moskatova*

## The Circulatory Turn

In today's society, digital images seem to circulate and move with ease. They are networked, streamed, presented on social media, and passed between small and portable screens such as smartphones, laptops, or tablets. Film and photography, formerly projection and print-based visual media, are consumed on digital displays and distributed via transmission and networking technologies on a regular basis—a characteristic that was associated with television and telegraphy in particular. On the networks, images are sent, received, and shared: whether recorded with a smartphone, extracted from a film or television show, appropriated or recycled, they are commented on, forwarded, linked, or liked on proprietary platforms. Images that were usually concealed in private, such as snapshots or home movies, are transformed from an intimate to a communal activity and appear in public, thereby undermining the traditional difference between the professional and the amateur (Rubinstein and Sluis 2008, 10). Becoming increasingly mobile, networked images are thus fed into circulation processes in which the medial positions of sending and receiving can change in unpredictable ways. They can not only move and animate what is represented by means of cinematic, televisual, or videographic techniques; they are themselves also on the move. Within seconds, they traverse great distances, geographic and political spaces, but also different symbolic contexts, media environments, and institutions.

Accordingly, the discourses of mobility, circulation, and networks have come to supersede the debates on production, indexicality, and manipulability that dominated early conceptions of post-photography and post-cinema (cf. Hagener, Hediger, and Strohmeier 2016; Gerling, Holschbach, and Löffler 2018; Henning 2018; Rubinstein and Sluis 2018). The crisis discourses of the digitally induced death of the photographic and cinematic, which primarily mourned the supposed loss of the material and semiotic media-specificity of the analog (see, among others, Doane 2008), have been replaced by diagnoses of "ubiquity" (cf. Fetveit 2013; Hand 2012). With them, the boundaries between moving and still images are regarded as becoming blurry within an incessant stream, update, and flow of mobilized net-

worked images (Lister 2013, 8; Gerling, Holschbach, and Löffler 2018, 126; Henning 2018, 131–133). After being concerned initially with the technological transformation from grain to pixel, from analog image carriers to image files, the caesura of the digital is now linked to connectedness, circulation, and the dissemination of photographs and films as well as their embedding in digital infrastructures (Gerling, Holschbach, and Löffler 2018, 8).

Especially since the early 2000s, circulation has enjoyed a theoretical boom in the discourses of digital media, promising to offer alternatives to prevalent methodologies that privileged either production or consumption, authors or audiences (Straw 2017, 427). In contrast, the shift to cultural circulation meant "to study the distances across which cultural forms travel, the rhythms of their movement, and the conditions which make possible various kinds of encounter" (Straw 2017, 428). Instead of being conceived as a supplementary, middle term between production and consumption, circulation aims to relate and encompass the processes involved in all three (Straw 2010, 25), emphasizing its active contribution to the production, meaning, and content of images as well as their redefinitions though time and space. In participatory online culture, this encompassing understanding becomes important for describing diverse media practices such as sharing, commenting, and disseminating content via social media platforms—with virality and memetics being their most visible manifestations. For Henry Jenkins, Sam Ford, and Joshua Green, circulation or "spreadability" even marks a re-organization of power hierarchies within media industries: while distribution designates top-down, centralized processes of dissemination typical of traditional mass media and the broadcasting of professional content, circulation "signals a movement toward a more participatory model of culture, one which sees the public not as simply consumers of preconstructed messages but as people who are shaping, sharing, reframing, and remixing media content in ways which might not have been previously imagined" (2018, 2). Therefore, circulation highlights social interaction, phatic communication, community building, and fan activities involved in the sharing and gift economy of the web. Moreover, these circulatory practices shift the focus from individual media content and its meaning to rhythms, speed, and patterns of transmission, because within a culture of overabundance they say more about the cultural role of media than isolated artifacts (Straw 2017, 429). Notably, social media and internet support a culture of bits, which can be combined and recombined, retweeted or reworked endlessly: "In a given culture of circulation, it is more important to track the proliferating copresence of varied textual/cultural forms in all their mobility and mutability than to attempt a delineation of their fragile autonomy and specificity" (Gaonkar and Povinelli 2003, 391).

In the discourses on the circulation and mobility of images, networked photography became a privileged medium of examination. Here, circulation addresses the new "public life" of snaps (Chéroux 2019, 7; see also Rubinstein and Sluis 2018) and

helps to grasp the transformations of the social uses and functions that were enabled by the media constellation of photography, internet, and mobile phone. Being an everyday apparatus intended for personal use and portability, the smartphone quickly replaced cameras as a recording device in amateur contexts. Being a networked device at the same time, the smartphone fostered connected photography and its mobilization as small digital files—easily to copy, manipulate, reproduce, transmit, upload, or download. For the French photo historian Clement Chéroux, this social mobilization and dissemination even constitutes a third revolution in the history of photography, characterized by an acceleration and increase in instantaneity (2019, 8). According to him, the evolution of photography has often been described as a great narrative of instantaneity. The early slow photography became accelerated, firstly, through the reduction of exposure times due to the development of light sensitive materials. Later, instant photography, exemplified by Polaroid, shortened the time of development and accelerated the consumption of images. Finally, Instagram contributed to the third revolution of instant sharing and publicity. This third shift retroactively changes the relevance of this photographic activity: whereas the third stage was slower and less visible in former times, networked photography revealed that dissemination and sharing were its mode of existence all along, preventing a reduction of photography to shooting and printing (Chéroux 2019, 8).

Chéroux's observation is quite remarkable because it implies a re-evaluation of basic concepts of image theory. It suggests not so much that the circulation of images is technologically or conceptually limited to the realm of the digital, but rather that the rising traffic of digital photographs, films, and videos in our time invites us to re-examine the historical and theoretical relevance of images' mobility. As Thomas Nail notes, we are witnessing a mobilization of digital images on a new scale, resulting in a new perspective on images in general:

> The centrality of the movement and the mobility of the image have never been more dramatic. And just like the Copernican revolution, the aesthetic revolution of the image has consequences not only for the way we think about the contemporary image but for the way we think about all previous images as well. The contemporary mobility of the image lets us see something new about the nature of all hitherto existing images. Only now are we able to understand that movement and mobility have always been at the heart of the image. (Nail 2019, 1–2)

Of course, images' mobility was addressed theoretically and historically before digital networks made it overtly relevant. Particularly in art history, such questions were raised. Aby Warburg, for example, who is known for his interest in motivic and physical image migration through space and time, developed many terms and methodologies in order to map the cultural itineraries of images. In 1905, he coined the notion of "Bilderfahrzeuge," literally meaning "image vehicles." Initially, this

notion referred to carpets that were produced in Flanders and were transported to Florence (Heil and Ohrt 2016, 36). For Warburg, the carpets were the prototypical image vehicle. They became mobile by detaching themselves from the walls and through the reproducibility of their motifs (Beyer et al. 2018, 9). Later in the 1920s, he renamed them "automobile Bilderfahrzeuge," adding the idea of automobility, and extended the notion to different carriers such as graphic reproduction, canvas, books, or scripts that supported the geographical and historical migration of images (Heil and Ohrt 2016, 8, 36). 'Automobile image vehicles' enable the transport of pictorial formula, which Warburg tried to trace all his life, eventually leading to his famous project, the *Mnemosyne Atlas*. Whereas Warburg's interest in migratory processes is strongly related to his understanding of the history of arts and culture, with the "afterlife of antiquity" (Nachleben) being its primary model, his notion "Bilderfahrzeuge" seems to anticipate one of the basic differentiations of image theory, namely the difference between image carrier and image object (Beyer et al. 2018, 10). In their introduction to image theory, for example, Wolfram Pichler and Ralph Ubl explicitly refer to image carriers as "image vehicles," distinguishing them from image objects (2014, 20–25) and thus signaling the importance of detachment for the concept of the image.

According to the art historian Jennifer L. Roberts, the transportability and portability of images is the very precondition for our modern understanding of image and art autonomy. It is due to the detachment of an image from a specific place that basic pictorial differences can emerge:

> The portability of pictures was integral to their historical emergence: easel painting was developed in the early Renaissance as a way of detaching images from fixed social and spatial contexts. The advent of the canvas support allowed for a light surface, easy to move and independent of any particular architectural surround. And the strategies that led to the development of the object now called 'a picture' (the bounding frame, the internal relation of forms and narratives, and especially the deployment of linear perspective) worked similarly to virtualize the image and liberate its internal space of representation from external space through which it moved. Its space of illusionistic reference, in other words, was sealed off from its space of physical referral. The resulting geographical autonomy of picture format would come to exemplify the aesthetic autonomy that defined modern art theory from Kant to Clement Greenberg. (Roberts 2014, 2)

The autonomization and dislocation of the visual is closely linked to the differentiation between representational and real spaces, which is enacted, among other things, by the frame of the picture. Following André Malraux, Vinzenz Hediger also emphasizes that the circulation rather than the production of images is constitutive for the formation of an expressive aesthetic object that can be contemplated as an independent entity (Hediger 2016, 17–19). Consequently, he denies its supplemen-

tary, retroactive character and subordination to production or reception (Hediger 2016, 18).

Furthermore, it is a very telling coincidence that Nail's argument on the changing concept of the image in view of its digital circulation echoes the famous proposition made by Walter Benjamin (1969), namely that the mechanical reproduction of modern mass media has forever changed the notion of art, since it facilitates the spread, dissemination, and multiplication of images in space and time. Of course, the history of images as commodities within global capitalism aligns reproduction with processes of circulation and spatial and temporal mobility. Nevertheless, it seems that Benjamin's theses were explicitly revisited as processes of circulation and mobility only in recent times. Film and photography theory traditionally focused on "*referential reproducibility*," i.e. the reproduction of physical reality and issues of indexical trace; however, digitization made the second form of reproduction—"*circulatory reproducibility*," which addressed processes of multiplication primed for circulation—more visible (Balsom 2017, 4–5). Indeed, this new visibility in the digital realm prompts an increased theoretical and historical interest in images' mobility and circulation. Although not completely unprecedented in terms of scholarly study, this interest is reflected in new research in the fields of film, video, and photography that starts out from current digital image practices and notably coincides with a conceptual reevaluation of media formats.

In the photography discourses, this new visibility of images' mobility leads to theoretical and historical reassessment of photography as a mobile medium. For example, Michelle Henning argues that the mobility of images was merely accelerated by digital networks, while photographs were on the move from the moment of their invention: they were small in size, portable, and reproducible (2018, 7). Therefore, she invites us to question one of the fundamental assumptions of photography theory: instead of focusing on photography as a static medium aiming to freeze a moment, she conceives photography as an itinerant image—an image which is traveling, unfettered, migratory, journeying, displaced, wandering, and vagabond (Henning 2018, 7; see also her article in this volume). Its mobility and increasing acceleration is characteristic rather than incidental (Henning 2018,7). Analogously, for André Gunthert (2014), "connected photography" transforms the social functions of the medium due to the ability to share and show images instantly on social media and image platforms, stimulating a historical reevaluation. His notion of the "conversational image" captures the shifts in the social status of photography. According to him, images are acting more and more like speech. They are no longer simply an object of communication, but rather means of communicative, dialogical acts (Gunthert 2014, 4–5). Whereas wired photography is often regarded as crucial for the history of discrete image (see Dentler's chapter in this volume; Rothöhler 2018, 141–154; Chéroux 2019, 7), in Gunthert's account, the illustrated postcard becomes a precursor of the digital conversational image and a

valuable example in the history of phatic communication. With it, mail art, which proliferated in the 1960–70s, also comes to the fore as an interesting step within the archaeology of visual networks and communities of sharing (Held 2005). And to give a last example: In his history of operative portraits ranging from Lavater to Facebook, Roland Meyer (2019) discusses photographic portraits explicitly from the vintage point of circulation, as evidenced by proliferating image flows on social media as well as by the *cartes de visites* popular in the 19th century. He argues that the quantitative overabundance and the implicit serialization of images in distributive contexts necessitate a logistical perspective that is able to explain how standards, protocols, and formats regulate and manage the circulation and dissemination of images (2019, 26; see also Nicole Wiedenmann's article in this volume). Being technical standards, formats affect basic material features of image carriers, such as their size, form and aspect ratio, and influence how images can be incorporated into larger technical ensembles, such as albums or archives (Meyer 2019, 27).

In studies on moving images, we can observe a comparable interest in circulation and an emphasis on the role that formats play for the mobilization of images in analog and digital realms. In her work on film and video art in circulation, Erika Balsom relates the mobility of moving images to the generation of aesthetic, cultural, and economic value implicated by the terms reproduction, original, and copy (2017, 11). Besides simply being a transportation of images in time and space, circulation significantly defines the boundaries of media. According to Balsom, experimental film or video art are distinguished less by media-specific materialities and aesthetics, and more by the economic and infrastructural logics of circulation (2017, 15), which is organized historically around different formats, such as 8 mm, 16 mm, VHS, DVD, mp4 or FLVs. Formats are closely connected to circulation and distribution because they imply different forms of compression and compactness. Smaller files are easy to transmit over networks, while smaller objects are easier to transport on the road. Although the term compression is usually applied to digital files, Jonathan Sterne (2015) indicates a much longer history, which can also include the size and material form of media containers such as films reels or DVD boxes. Importantly, formats have an infrastructural dimension: they are embedded in technical systems, whose parts have to be compatible and interoperable. For film historian Haidee Wasson (2007; 2013; 2015), formats are a crucial notion to study mobile cinematic infrastructures and the relocation of film and cinema to nontheatrical sites such as museum, home, and military or educational contexts (on relocation, see also Casetti 2015). Small film gauges call for smaller, lighter and portable cameras and projections screens. They facilitate nontheatrical circulation and invite reflection on the history of relocation before it became identified with watching films on mobile screening devices such as smartphones, laptops, and tablets (Wasson 2007, 77–79). On the move, relocated images traverse different devices, screens, interfaces, and corresponding technological networks, being subjected to

different screen sizes, proportions, and compression techniques. Hence, the content needs to be adapted to new sites of display, producing distortions or particular aesthetics of scale and formatting (Wasson 2007). In Lucas Hilderbrand's (2009) account of bootleg histories of videotape, VHS-format is addressed as a "middle-aged" medium, often neglected within the transition from analog to digital, and thus contextualized as an important precursor of digital circulatory practices. In several case studies, he shows how VHS enables cultures of access, structures legal and illegal practices of circulation and filmic relocation, and shapes affective attachments and communities of exchange. Being a low-res, small format, VHS is easily mobilized in personal networks and sent by mail.

Although this brief recapitulation is by no means exhaustive, it is exemplary of the new methodological, analytical, and historical significance of circulation in visual media studies drawn upon by this edited collection. Expanding the scope beyond digital images, this volume is also concerned with the many ways that images are and were on the move before digitization: Images travel as engravings, postcards, banknotes, postage stamps, carpets, advertisements, flyers, or passport portraits. They are transported by mail, ship, or plane and disseminated in telecommunication networks, magazines, or newspapers. Images are carried in envelopes, intimate jewelry, boxes, albums, frames, or reels. Taking the contemporary mobilization of images in digital networks as a starting point, the goal of this volume, therefore, is to re-examine the historical, aesthetical, and theoretical relevance of image mobility more generally. It is especially interested in considering the materiality of circulation. Instead of limiting its questions to social practices revolving around viral and phatic communication today, or focusing primarily on the motivic image migration of iconography, the volume suggests taking a more integrative approach and interrogating the conditions that make the transmission and circulation of images possible or conversely, stand in its way. More specifically, it addresses the trajectories, spacing, deferrals, and intervals between production and exhibition which lend weight to the materiality of mobile images.

## Trajectories: The Materiality of Circulation

Today's strong association of circulation with digital culture, as expressed by the notion of "spreadability" (Jenkins, Ford, and Green 2018, 4–9) and different views on virality, can be misleading because of its "fantasies of total and immediate circulation" (Brunet 2017, 13). On the one hand, the term is reduced to the activity of human beings, ignoring the networks and infrastructures that need to be established and sustained over time. Circulation has to be enabled. It is an aim rather than a reality or a starting point: technical artifacts and structures, and organizational and socio-economic relationships have to be implemented in order for

signals to move (Parks/Starosielski 2015). It includes different circulation systems such as infrastructures of transport, postal services, or communication networks, which may even rely on each other. On the other hand, virality suggest that images and other media texts propagate by themselves, in isolation from human and non-human agents as well as from technological, cultural, and semiotic relationships. This idea of a self-regulatory process underestimates the fact that images—in order to circulate—have to be set into motion first.

Similarly, the logistics researcher Chua notes that circulation is often reduced to an abstract and immaterial idea of the movement of things, people, and ideas (Chua 2020, 106). In these cases, it is just a metaphor for mobility, deprived of material embeddedness and any sensibility for conflicts, politics, and inequalities (Chua 2020, 106). Yet the "logistics of images" (Rothöhler 2018, 6–10) are dependent on material, infrastructural, technical, political, economic, and social resources and preconditions. In order to traverse space and time, images rely on a multiplicity of human and non-human actors and actor-networks (Callon 1986; Latour 1993; Law 1992). Human and non-human actors transport and safeguard images, ensure technical compatibility in transit, or introduce interference and noise. Thomas Bachler's photograph (Fig. 1.1), which serves as the cover image of this book, impressively demonstrates the logistics of images and their implications by engaging with the materiality of transport and the heterogeneity of actors involved.

The filigree black-and-white photo is named after its own journey: "From Düsseldorf to Kassel." The image is part of Thomas Bachler's photo series *Souvenirs* (original title *Reiseerinnerungen/Travel Memories*). In this series, the German photographer delegated his artistic agency to the postal service and transportation networks. After converting a suitcase into a camera obscura and equipping it with photosensitive paper, Bachler sent it as a postal package. In this way, the photo paper could record its own travel. The black-and-white, mostly abstract images are entitled "From Stuttgart to Kassel," "From Cologne to Kassel" or "From Hamburg to Kassel," etc. The *Souvernirs*-series alludes to the touristic snapshot photography that is meant to document a journey and authenticate an experience (Potts 2018, 94), but also to one of the central topoi of photographic theory: the mnemotechnical function of photography. In this case, however, the human recollecting subject is absent. On the contrary, Bachler's project is about relinquishing all control to the pinhole camera. As the photographer remarks, "not being responsible for the motifs in your own photography is very refreshing. It's a task the German Post Office actually took over for me. Once posted at the counter, the pinhole camera parcels of my own design literally exposed the entire delivery process, right through to their arrival at my apartment." (Bachler 2019, n.p.) Unusual recording techniques and devices characterize many of Thomas Bachler's photographic experiments and pertain to his conceptual artistic strategy. Each series employs a specific self-constructed apparatus. In the series *Bon Voyage*, for example, Bachler turned a small

truck into a camera obscura and placed 1.5 x 1 m photo material inside the vehicle, which recorded a 100 km-long drive along the freeway. While the images from *Souvenirs* mostly show abstract patterns of traces, the recordings from *Bon Voyage* depict black vanishing points.

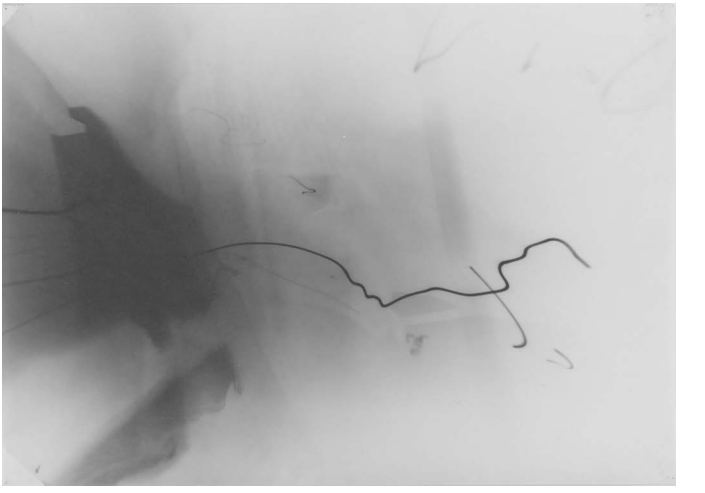

Figure 1.1: Thomas Bachler, *From Düsseldorf to Kassel*, from the series *Reiseerinnerungen (Souvenirs)*, 1985.

Bachler's photographs subvert the photographic dispositif, especially its industrially standardized form of the snapshot. Simultaneously, they reveal how images can register their very mobilization and use materially. During transportation, images are subject to the materiality of routes and infrastructures and submitted to the standards and protocols of transmission technologies. They are exposed to ecological milieus and territorial politics or introduced to economic considerations. As several authors observe in this volume, images accumulate material traces, marks, and inscriptions of their trajectories. As Jonathan Dentlers argues in his chapter, wire photography's low-resolution images indicate the technical processes and procedures during which the images are transformed into data and back. The dots and pixels, blurred edges, dropping out of middle tones or the manual retouching uncover the usually hidden and invisible infrastructures of transmission, complicating the traditional understanding of the objectivity and indexicality of photographic images. As explored in Ellen Handy's study, stamps, labeling, or greeting texts can attest to the circulatory routes of postcards. Lucas Hilderbrand conceives the material traces of wear and tear that videotapes endure in circulation as bootleg aesthetics. This bears witness not only to a spatio-temporal trajectory of

videotapes, but also to the affective attachment of repeated consumption and the processes of auratization that videotapes undergo. Whereas Griet Bonne shows how the circulatory reproducibility of Rubens' artworks involves continual changes of media and media specific (re-)materializations, Maria Schulze and Sarine Waltenspül trace how the complex histories of use and reuse of scientific films can imply reformatting, resignifications, and material transformations of footage. Importantly, these different case studies elucidate the way that the "logistics of images" are a complex process of negotiation between the stability of forms, "translation without corruption" (Latour 1990, 28; see also 1997, 179), and the undesirable transformation that leaves visible material traces of damage, wear, compression, or pixilation, producing "poor images" (Steyerl 2009) or encrusting images with historicity. In other words, the material traces of circulation speak of both aesthetic pleasures and technical failures, increased value and noise, a desire for transformation, and the necessities of stability or conservation.

Size and weight—or more broadly the formats—also affect the mobility of analog as well as digital images and materially condition their circulation. Large and heavy pictures slow down circulation and require more human and non-human agents for their mobilization than small and light ones. As art historian Jennifer L. Roberts notes with regard to paintings, transit and transport foreground the materiality, ponderousness and thingness of images in the first place: "Everything is heavier when it has to be picked up and moved . . . . The thingness of a picture is somehow not definitively established, in other words, until it has to be moved" (Roberts 2014, 8–9). Chéroux also emphasizes the relevance of material features for the mobility of images, while being surprised by the discovery that "not a single line in any history of photography addresses the weight of images" (2019, 10). Although digital images are often regarded as dematerialized, which is supposed to increase the speed and effortlessness of their circulation, we are not dealing with weightlessness, but rather with a transformation of measurement: instead of being scaled in kilograms or pounds, digital images are measured in file sizes that indicate a virtual kind of weight. Moreover, they are distributed materially and processually: As data packages, they traverse different technical and material infrastructures, channels, milieus, nodes, and surfaces, repeatedly "acquiring shifting materialities underway" (Fetveit 2013, 96). In doing so, their virtual weight renders the images adequate to the infrastructures and material realities of potential associated actors.

More often, however, it is the low-resolution of pixelated images that draws attention to "*the specific, layered materialities of digital technologies*" (Casetti and Somaini 2018, 88). Pixelated aesthetics and low-resolution are visible traces of compression, and importantly of circulation and the accompanying process of transformation. In her much-quoted paper "In the Defense of the Poor Image," Hito Steyerl declares the low-res, compressed, reedited, ripped, repeatedly copy-pasted and decontextualized images "the lumpen proletarian in the class society of appearances" (Steyerl

2009, 1). The "poor image" demonstrates the aesthetics of circulation and testifies to the digital visual culture that valorizes velocity, spread, and participation: "It transforms quality into accessibility, exhibition value into cult value, films into clips, contemplation into distraction" (Steyerl 2009, 1). "Poor images are poor because they are heavily compressed and travel quickly" (Steyerl 2009, 7). Images lose quality, even to the extent of abstraction, by being reformatted and compressed several times and thus becoming multiple-generation copies. Hence, the aesthetics of circulation is interrelated with certain image formats operating on lossy compression codecs, such as JPEG,[1] AVI, or the notorious mp4, but also with small formats such as VHS or Super 8, to name a few analog equivalents of easy mobilizability and lo-fi aesthetics.

As mentioned above, issues of compression and compression formats go well beyond digital media. More generally, compression speaks of infrastructures and their material conditions:

> For media scholars, this 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 of 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. (Sterne 2015, 36)

Given that storage and bandwidth resources are limited and expensive, an efficient dissemination of (audio-)visual material becomes important. Compression is based on the elimination of data that are considered redundant. It reduces the amount of information, while increasing its spreadability. According to Jonathan Sterne, the traffic of compressed material even highlights "the distributed character of culture in our age" (2012, 1). By diminishing data to be transported, compression negotiates the capacities of a 'channel': the utilization of transmission technology; the speed of transmission; the scarcity of bandwidths and frequencies; the material, energetic, and monetary costs of transport; the number of necessary actors, and the aesthetically and perceptually significant transformations paid for transportation (Latour 1997, 177). This requires the accommodation of signals to infrastructures as well as the modification of infrastructures in order to enable them to carry different kind of signals (Sterne 2015, 34). Compression standards and formats can also embody old infrastructural conditions even if they have already been changed, and direct the focus on the materiality of circulation: "on the stuff beneath, beyond, and behind the boxes our media come in, whether we are talking about portable mp3 players, film projectors, television sets, parcels, mobile phones, or computers" (Sterne 2012, 11). Although circulation and infrastructures are often regarded as complementary terms—one addressing movement and the other connoting stability (Sarkar 2020, 117)—, it is more productive to think of them in terms of plasticity

and co-determination (Sarkar 2020, 121–122), or in terms of "trajectories," to use a notion of actor-network theory that designates the circulatory activity of networking.

## Networking: The A-Modernity of Circulation

Today, the notion of circulation has become ubiquitous in many discourses. It is applied to everything that is on the move and is able to span distances or change positions: viruses, containers, films, books, money, toxins, affects, short messages, electricity, water, or means of transport (Hagener, Opitz, and Tellmann 2020, 10). According to Straw (2017), the notion is used mostly in three contexts: economy, urban movement, and culture (although he ignores ecology). In economy, it addresses the relation between money and goods, raising the question whether goods have value in themselves or only acquire it in their market circulation (Straw 2017, 424). In present-day capitalism, circulation goes along with asymmetries in the process of globalization, which mobilizes money and goods while immobilizing people and limiting migration (Straw 2017, 425–426). In the context of urbanity, circulation deals with the governance of mobile people, goods, and ideas (Straw 2017, 424). It touches on issues of transportation systems as well as the biopolitical regulation of desirable and undesirable flows, as addressed by Foucault (2007, 34). In culture, circulation focuses on the dissemination of information, news, and artistic expressions and the ways cultural artifacts find their audiences (Straw 2017, 424).

However, the separation of the economic from the cultural, the aesthetic from the phatic, the media cultural from the urban notions of circulation, as Straw's account suggests, might emerge as reductive. Often, circulatory systems overlap. Postal networks, for example, rely on urban transportation as well as on maritime and air traffic, while the circulation of media objects can rely on postal networks in turn. Historically, a circulatory system may even co-evolve. As David Henkin has shown, in the USA, the postal service contributed to the proliferation of the then new medium photography, whose uses and potentials were still not clearly defined (2018, 48). Especially cheap postage rates facilitated interpersonal communication and communion by means of photographic portraits, which were a predominant application and a primary social use in the United States by the 1850s (Henkin 2018, 48–49, 52–53). At the same time, photography popularized mail for personal reasons. Therefore, Henkin stresses the close historical correspondence between photography and mail and the economic aspects affecting the conduction of (familial) relationships at a distance (Henkin 2018, 44). Comparably, Simone Natale notes that in the mid-nineteenth century, photography and the railroad were strategically aligned in the service of nation-building, governance, spatial conquest, and touristic travel, turning photography into a circulatory medium "with wings" (Na-

tale 2018, 38–39) and one of space annihilation usually connected to telegraphy, the railroad, or steam in the 19th century (Natale 2018, 44–45). Today, aesthetic and cultural artifacts are frequently consumed in buses, trains, or airplanes—either by using portable media such as magazines, newspapers, smartphones, IPods, or tablets carried by a person, or by watching stationary installed screens displaying news, navigational information, advertisements, or films in the means of travel, as Dominik Maeder elaborates in this volume. Here, media artifacts and people, information and matter are simultaneously on the move, and virtual and physical travel even seem to coincide.

Such examples of entanglement point towards the idea of the 'a-modernity of circulation'—to draw on Bruno Latour's famous criticism of modern processes of purification (Latour 1993, 10–12). If circulation is addressed in a-modern terms, we need to consider not only processes of separation and differentiation, but also processes of hybridization and translation between the technical and the social, the economic and the cultural, the human and the non-human, etc. (Latour 1993, 10–12). In the ANT, heterogenous networks of agency distributed between human and nonhuman actors are substituted for the isolated domains of economy, law, science, or culture, as they are conceived in the episteme of Western modernity (Latour 2013, 29–30; Law 1992, 381–383). Networks are first and foremost processes of relating, or more precisely: of associating. The notion "circulation" is crucial for the a-modern episteme of the ANT, insofar as the processes of network association are enabled by the circulation, mobilization, and trajectories of actors: "A network is not a thing, but the recorded movement of a thing. . . . It is no longer whether a net is a representation or a thing, a part of society or a part of discourse or a part of nature, but what moves and how this movement is recorded" (Latour 1996, 378). Following Michel Serres' theory of "quasi-objects" (Serres 1982, 224–234), actors, too, are conceived as unfixed "circulating objects" that undergo trials on their way and have to negotiate with others (Latour 1996, 374). In circulation, the actors transform and co-determine each other, acquiring stability, continuity, or power in the process (Latour 1996, 379). An actor thus circulates in a network *and* is simultaneously a network, i.e. "a network-*tracing* activity" or "a trajectory that is called a network" (Latour 1996, 378).

From this perspective, images do not simply circulate in given techno-social or techno-ecological actor-networks and adapt to them; instead, they actively contribute to the making and remaking of networks and logistical relationships by functioning both as "quasi-objects" (Serres 1982, 224–234) and as hybrid, distributed networks. Or to put it differently, images circulate as actors in agentially distributed networks and function themselves as hybrid networks. Importantly, as ANT often emphasizes in order to prevent misunderstandings, a network is a process full of negotiations and installments of relational ties that cannot be reduced to a ready-made infrastructure or an established technical arrangement

such as postal, telecommunication, or rail networks (Callon 1986, 28–33; Latour 2013, 31–32). In terms of ANT, a networked image is not automatically an image circulating online. More precisely, internet images and other kinds of images can be described as distributed image actor-networks. After being recruited, technical infrastructures and computer networks can become part of distributed image networks. The actor-network of an image is therefore both smaller and bigger than technical infrastructures.[2]

However, when tracing network building and trajectories of circulation, it is also important to think of limitations and restrictions. Circulation often connotes continuous flows and contiguity, thereby neglecting interruptions, blockages, disruptions, and breakdowns (Hagener, Opitz, and Tellmann 2020, 15). Image actor-networks of circulation may entail resistances to easy mobilization and even imply total interruptions of image flows. "For every image object or archive that circulates, . . . there are others that do not" (Phelan 2017, par. 8). The opportunities to circulate or to participate in circulatory networks are not equal and can cause exclusion and discrimination, both of human and non-human actors. Circulation networks follow particular rules. For example, as the histories of the early American Post Office indicate, people of color were not allowed to carry mail because the access to information and the opportunities to form a black informational community were regarded as dangerous for the existing power structures (Pottroff 2018, 624–627). Circulation was structured and disrupted by racial inequality (625). The postal network worked as a "classification system" that delivered only certain texts to certain groups of people by certain groups of people (626). Such classificatory and exclusive systems, of course, can stimulate informal or illegal circulation. Furthermore, as Lucas Hilderbrand shows in his study on Ted Haynes' film *The Carpenters* in this volume, circulation can be impeded legally due to copyright and economic interests. Furthermore, copies can be (temporarily) withdrawn from circulation by entering an archive or private collection, which is accompanied by special valuation and reevaluation of artifacts. As Sarine Waltenspül and Mario Schulz elaborate in their paper on the historical trajectory of Ludwig Prandl's flow film *Entstehung von Wirbeln bei Wasserströmungen* (*Production of Vortices by Bodies Travelling in Water*), changes in political regimes and power structures also affect the visibility and invisibility of images and audiovisual material, implying censorship, resignification, or even a material restructuring of content. Finally, art institutions and their economic models can limit circulation and rarify an object for selling and uniqueness purposes. Media of reproducibility such as photography and film can be authenticated and rarified by subjecting them to the logics of the limited edition and producing conflicts with their reproducibility. In recent times, avant-garde and experimental films, which historically struggled for visibility and a broader publicity in the realm of theatrical exhibition, suddenly face such limitations after entering into art spaces (Balsom 2017, 129, 136). Today, on social media platforms, content

moderation by human and algorithmic actors regulates the flow of images, limiting visibility for supposedly controversial content such as nudity, pornography, terror images, and other violence (Gillespie 2018; Müller-Helle 2020). Therefore, circulation needs to be complemented by the histories of "*uncirculation*" (Mancini 2017, 45).

## Contributions

In this volume, the term circulation is used in a broad sense in order to encompass different kinds of movements that images undergo in space and time. It includes travel, transport, transmission, sending, dissemination, reproduction, streaming, and relocation. All these different forms of movements have in common that they involve material agents, infrastructures, and networks for their realization. Circulation is neither an abstract movement of ideas or objects nor an activity by human beings only. It is a collaborative process deeply rooted in the materiality of the world, its resistances and affordances. This understanding of circulation is indebted to actor-network theory because it allows us to take into account the technical, social, economic, aesthetic, and other dimensions. In each case, the authors specify their particular understanding of circulation and trajectories and clarify whether they are using the related notion of distribution synonymously or giving priority to one of the terms.

The first section entitled "Image Networks and Networked Images" addresses the historical and conceptual relationship between networked, connected images, which proliferate in the digital realm, and other image technologies strongly reliant on vast, even overlapping infrastructures and agential networks, as they are conceived by the ANT. Of particular interest is the oscillation and slippage between images being entities circulating in networks, images being operational actors co-constituting networks, and images being distributed as networks themselves. The section is opened by Ellen Handy's article on postcards, inviting us to consider the parallels between today's image circulation in digital and social networks and the boom in the production and circulation of postcards in the early 20$^{th}$ century. Many millions of these photo-based postcards were circulated all over the world, their production dependent on heavy machinery and their transportation tied to rail, road, and postal networks. However, instead of simply offering a prehistory of the "conversational image" (Gunthert 2014) and its phatic circulation, Ellen Handy focuses on the material, ideological, economic, infrastructural, and logistical preconditions that have enabled postcards to become a mass medium in the USA, taking one of the largest American postcard producers, Curt Teich Company of Chicago, as a case study. In terms of ANT, the article shifts the focus from images as punctualized, stabilized, and blackboxed objects circulating autonomously to the actor-

network of postcard production and circulation. In the second article, Jonathan Dentler discusses the under-studied role of wire photography in global news media and gives insights into the long history and genealogy of digital images. By focusing on the visual traces that the process of telegraphic transmissions inscribed into the visual material, Dentler offers an infrastructural and logistical view on photography, emphasizing how the medium was tied to circulation and communication long before the advent of connected social photography. While telegraphic images travelled as electrical information and not as physical objects, it is only after World War One that the infrastructural and organizational conditions were in place to mobilize them on a regular basis. Moreover, his examination of human and non-human interventions that images are subjected to in business and telecommunication networks reveals the media hybridity of wire photos and complicates our contemporary understanding of digital visual culture. According to Simon Rothöhler, digital images proliferating online as memes, GIFs, viral videos, or selfies should be conceived as fundamentally distributed. To address images on the move, Rothöhler prefers the complex notion of distribution, which draws on several understandings simultaneously: on the concept of distributed agency as offered by the ANT; on the distributed structure of the internet network (in contrast to centralized or decentralized, as differentiated by Paul Baran, for example); and on images as being materially, spatially, and temporality distributed within logistical networks. In his chapter, he focuses on the de-aestheticized forms of distributed images that are mobilized mainly as data and optical information, thus constituting an "invisible visual culture" addressed to non-human technical agents in particular. The section is completed by Dominik Maeder, who focuses on moving images relocated onto the airplane, where they travel together with people and other goods. However, he argues that in-flight entertainment images cannot be properly grasped as mere objects of transportation. In fact, they exhibit infrastructural power and even take on the quality of infrastructural images by being an indispensable part of the operational logic of aerial passenger transport. Images in airplanes significantly contribute to immobilizing human bodies and managing fears, ensuring the unimpaired operativity of flying and its infrastructures. In this way, Dominik Maeder convincingly shows that the study of mobility or mobilization, increasingly gaining importance in media studies, needs to consider accompanying processes of immobilization and blockages of movement.

The section "Formats and Mobility of Images" examines the formatting of circulation. It draws on media studies approaches that closely link formats to the circulation, distribution, and dissemination of images. Formats can contribute to both easy mobilization and to the immobilization of images. Ensuring compatibility and interoperativity within infrastructures, they also help to question how images on the move can touch down at specific places and material sites of presentation. In her article, Nicole Wiedemann discusses the logistics of analog pho-

tography by using *cartes de visite* as a case study. In Europe and the USA, the 19th century was an important period of analog images' mobility. In addition to the increased circulation of goods, the expansion of free markets, and the annihilation of space by new means of transportation, there was also an almost revolutionary proliferation of portrait photography at that time. This was enabled, among other things, by the standardizations of the photographic format implemented by Adolphe-Eugène Disdéri. His *carte de visite*-format triggered an increase in the circulation and dissemination of photographic portraits, and with it a veritable "cartomania." As Nicole Wiedemann shows, this mobilization in turn relied on diverse organizational networks. At the same time, the small size and light weight of the format fostered its easy insertion within these structures and helped to mold them. In the second chapter, Lucas Hilderbrand traces the screening and legal trajectories of the cult film *Superstar: The Karen Carpenter Story* (Todd Haynes, 1987). Although the film was withdrawn from official distribution after Haynes received cease-and-desist letters threatening copyright litigation over the film's unauthorized inclusion of the Carpenters' music, it continued to circulate via bootleg videotapes, semi-secret screenings, and eventually DVDs and downloadable MPEGs. *Superstar* was a film phenomenon of the home video age, as the video format aided the duplicating and circulating of the film for a wide viewing public. Because the film has circulated historically through direct, interpersonal copying and loaning, the cassettes themselves have become mementos of specific people or time periods in their owner's lives by materially registering the histories of repeated viewing and multiple-generation dubbing. *Superstar* bootlegs' material traces bear witness to the aesthetics and affects of circulation. In the final chapter of this section, Frank Bauer and Philipp Kurth focus on the formatting of networked streaming and pay attention to the often-neglected difference between container formats and codecs. In particular, the authors discuss the relationship between container formats and compression algorithms and their impact on the transmission of large amounts of video data in production and distribution. While compression undoubtedly negotiates the channel capacities and facilitates the mobilization of content, Frank Bauer and Philipp Kurth argue that the characteristics of container formats and codecs also define what makes a download a stream, challenging the traditional difference between storable files and transient transmission, i.e. between temporarily immobilized and mobilized distributed image data.

The final section "Trajectories and Traces" is dedicated to tracing the paths images take on the move or—to modify a catchphrase of ANT—to following their movements. Although the mobility of images is often associated with movement in space and bridging geographical distances, this section also considers how images circulate, spread, and travel across times. Crucial for this task of tracing are the material and symbolic transformations and accumulated traces of use. Travel-

ling through space and time, images become reformatted and noisy; they change their material support and cultural meaning; become accelerated or slowed down; degrade or increase their value. In the first chapter, Michelle Henning questions the simplified opposition between pre-digital and digital photographic images. Specifically, the characterization of the digital image as mobile, transitory, virtual, and immediate depends on a characterization of chemical photography as relatively static, fixed, and solidly material. Contrary to this, she emphasizes analog photography's mobility, recognizing its role in unleashing images from their fixed place by situating photography within broader theories of modern capitalist acceleration. She argues that digital and pre-digital photographs' mobility and temporality depend on their ability to be assembled and reassembled and to change material supports. While this speeding-up is framed mainly as a process of dematerialization, Michelle Henning focuses on the dirt and noise that images accrue on the move, thus revealing material infrastructures and channels that produce it. Griet Bonne traces the circulatory reproducibility, i.e. dissemination and multiplication, of Peter Paul Rubens' work across Europe and historical periods. Rubens was one of the first Flemish artists to be aware of the commercial and legal conditions of mechanical reproduction, who was also consciously engaged with the reproducibility of his oeuvre, via both multiple painted versions of a single composition and via prints. By comparing Rubens' 300$^{th}$ and 400$^{th}$ birthday celebrations, in 1877 and 1977 respectively, Griet Bonne examines the mobilization of Rubens' images by means of different technical media, ranging from engravings to photography, postcards, film, and television. She unravels the impact of these material transitions and changed mediations on Rubens' images, focusing on the close interrelation between dispersive and concentrating logics, i.e. between the spatial, temporal, and material spread on the one hand and the symbolical construction of an original oeuvre, which in turn stimulates tourism as a prototype of modern travel, on the other. Whereas Griet Bonne implicitly sketches an object-biographical approach, Mario Schulze and Sarine Waltenspül explicitly tie together the concepts "trajectories" and "object biographies" and critically discuss both in terms of their productivity for tracing the circulation of scientific films. Following the historical and geographical paths, reformatting, and (re)uses of the flow film *Entstehung von Wirbeln bei Wasserstömungen* (Ludwig Prandtl), the authors aim to understand the multiple, subtle ways of intertwining science, politics, and the public sphere, and to disclose the cultural, intermedial, and aesthetic transformations accompanying the film's trajectory. To do so, they analyze how films circulate through space and time—in their changing materiality (from 35 mm nitrate film to 16 mm safety film to different file formats) and visuality (from a rough cut to re-edited found footage to digitally color-graded and noise-reduced) as well as their shifting epistemic functions (between measurement, research, teaching, and popularization). In the final chapter of this section, Tomáš Dvořák traces a rather extreme form of image trajec-

tories: images sent to outer space. These include the Pioneer plaques from 1972 and 1973 (diagrams engraved into gold-anodized aluminium plaques that provide information about the origin of the spacecraft), the Golden Records carried by Voyagers 1 and 2 (both launched in 1977 and including, among other things, a collection of 115 images encoded into a video signal), and Trevor Paglen's art project *The Last Pictures* (2012). These images are designed to last for billions of years and to move not only in space but, more importantly, in time. Their materiality is therefore destined to resist transformations in transport, to avoid traces of travel. Tomáš Dvořák conceives these images as time capsules, whose trajectories call for a reconsideration of our anthropocentric media and image theories.

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## Notes

1 Strictly speaking, JPEG is a compression codec, while the actual container format is named Jpeg Image File Format (JIFF). Often, JPEG is mistakenly regarded as a format and used as a synonym for JIFF. On the difference between container format and codec, as well as on their significance, see Frank Bauer's and Philipp Kurth's chapter in this volume.

2 In the ANT, "small" and "big," "micro" and "macro" are relative categories (see Callon and Latour 1981).

# Networked Images and Image Networks

# 2. Greetings from Chicago: Image Networks and Infrastructures of Postcard Production and Circulation[1]

*Ellen Handy*

## Introduction

The increasing speed, mobility and distribution of digital photographic images today, particularly through networks of social media and web presentation, produces a dazzling oversupply of images that can only be understood in relation to their circulation, and this we may consider an emblem of the condition of the twenty-first century. Yet this phenomenon closely recapitulates that of the early twentieth-century's boom in the production and circulation of photographic images as postcards through photomechanical reproduction, making it propitious to reconsider the proliferation and transmission of postcards. That vast sea of images has a history, valuable as a foundation for interpreting the near-infinite trajectories of images today. Now almost obsolete as an image genre, postcards are nevertheless a recent enough memory today for most adults that they haven't yet quite been lost to the antiquarian status of daguerreotypes or Victrola cylinders, perhaps because they adumbrate aspects of our present culture of digital images.

The photographic postcard genre was born in the late nineteenth century and came of age c.1900. Many millions of photo-based postcards were transmitted globally, their production dependent on heavy machinery rather than software, and their circulation tied to rail, road and postal networks. In America, sites that were not really sights became views for the tourist market, as virtually every small town was systematically photographed to produce postcards available to be mailed to remote destinations. Postcards were on the move in vast networks of production and circulation: Original source photographs were created in situ, transmitted to an urban postcard factory for printing, and returned for sale as mass-produced print runs of postcards to the locality depicted. Once purchased, they might be inscribed, mailed and preserved in albums. Postcards arriving by then-rapid and reliable postal delivery were precursors of e-mail; in their pairing of brief inscriptions and images, they were precursors of text messages, and since unlike formal,

sealed letters, they were open to be read by all, they somewhat resemble tweets as well. Moreover, postcards are part of the history of "conversational images," i.e. images we converse *with* and not *about* that proliferate in the form of connected photography we share on the internet (Gunthert 2014, par. 23).


Figure 2.1: Curt Teich Company, *Greetings from Chicago*, 1940s.

The enormous production of topographical photographic postcards between 1900 and 1950 by the Curt Teich Company of Chicago, proud operator of "the largest postcard factory in the United States," offers a case study of the circulation and distribution of images and the infrastructural networks necessary for it.[2] Best known for the "Gruss aus" or "Greetings from" postcard format (Fig. 2.1), in which the name of a city was formed from large letters filled with images of that city's icons, the Teich Company represented the nation with postcard views of nearly every municipality.[3] The millions of postcards they produced and disseminated demonstrate a curious amalgam of image genres, including reportage, advertising, mass-produced nostalgia, and more. Views of landscapes, cityscapes, sights and business premises constituted the bulk of the Teich postcard repertoire, but it also included popular ethnographic images and hand-drawn racialized caricatures of African-Americans, Native Americans and Asians. Although the postcard phenomenon was a global one, the Teich Company almost exclusively specialized in postcards of American sites. Jeffrey Meikle, the dean of Teich postcard studies, subtitled his history of the company's production "Imaging of a Nation" (2016). Teich's postcard empire relied on an industrial infrastructure connecting producers, retailers, salesmen and individual consumers or collectors. In my paper, I therefore propose to address postcard circulation not so much as a process of interper-

sonal communication and sharing images—like it is often done in the discourses of digital images (Cheroux 2019; Gunthert 2014). Instead, I will focus on the image networks and infrastructures that enable the production, dissemination and consumption of postcards and thus condition their mobility in the first place. In terms of ANT, I thus examine postcards as networks rather than as punctualized black-boxed actors (Law 1992; on the notion of circulation, see also the introduction to this volume).

## Modernism, Modernity and Commercial Printing in Chicago: Trajectories Outward from the Center of the Continent

Industrially produced mass-cultural artifacts of printed ephemera like Teich Company postcards are certainly remote in form, audience and purpose from works of avant-garde art normally described by the term modernist. Postcard images' formal language was conventional rather than ground-breaking. They are usually multiply authored rather than the works of identifiable masters, and they lack many of the attributes of the modernist aesthetic Andreas Huyssens so usefully summarized in "Mass Culture as Woman: Modernism's Other" (1987, 7). That postcards are modern, however, is evident—the postcard form became prominent worldwide just as the twentieth century was beginning, and its mass production in factories using state of the art printing technology establishes it as an image category imbricated with the modern period and its methods (Brunet 2017). The production of Teich postcards and their outward trajectories from factory to the sites of their sale and consumption across the continent was specifically Chicagoan, and harnessed the capabilities of the city's industrial infrastructure. Moving the Teich Company's production from the category of modern mass culture to that of modernist expression requires a reconfiguration of the latter category. It is argued that Chicago modernism has its own characteristic forms, more popular, audience-oriented and comfortable with commerce and consumption than the more hermetic and austere vanguard practices of other venues (Olson 2017). Thomas Dyja emphasizes the modern corporatization so characteristic of Chicago culture, describing the city as "navigating the transformation of the cultural ideal of the common man into a national mass-marketing strategy" (2013, 336). Associating photographic postcards with modernism requires finding space for industry and commercial distribution within the sphere of artistic production, as is logical in the context of Chicago.

The city's printed images both represent and result from its own transformations. Carl Sandburg's celebrated personification of Chicago emphasized the industries which played central roles in reshaping the economy of the nation, and joined urban mechanized production to agricultural productivity in generating wealth and promoting growth.[4] Taking in photographic images from afar and transform-

ing them into mass produced image products like postcards paralleled the older meat processing and grain transshipment industries of Chicago. Like them, the printing industry relied upon the city's roles as "player with railroads and the nation's freight handler" for the circulation of its products. Early twentieth-century commercial image printing was a manufactory that paired the might of the machine with skilled human labor in factory settings, and its products helped drive further commercial and industrial development. The city's excellent rail (and later, highway) connections with the rest of the country made it the center of a national distribution network for raw materials and commodities.

The Chicago printing industry has attracted the attention of historians who understood its expansion as inevitable owing to location. Local booster Walter D. Moody was quoted in the *Story of Chicago in Connection with the Printing Business* to the effect that:

> Transportation is the greatest power governing the growth or retrogression of a city. Thirty railways terminate in Chicago. This city is within a night's ride of 50,000,000 people. Any one of these can get into a train after dinner in the evening and get to Chicago in time for breakfast. Within this circle of 500 miles is more than half the population of the United States—and Chicago is the center of the circle. (Reagan Printing House 1912, 62)

Comparing New York to Chicago, Elizabeth Baker similarly notes:

> The high cost of carting tons of paper from railroad to warehouse, from warehouse to plant, thence, printed and bound, back to the railroad, has made it impossible for New York printers to bid against those who enjoy a railroad siding at their door. (1969, 85)[5]

Chicago printing was a growing industry for the city, central to the practices of advertising, mail order marketing and mass communications transforming modern consumer experience. The photomechanical reproduction enabling these centrifugal image torrents is closely linked to modernity in Walter Benjamin's celebrated essay (1969), but the twentieth century proved to be not merely the age of mechanical reproduction, but also that of the *dissemination, exchange* and *consumption* of images. Reproduction mandates circulation, each iteration of an image implying multiple possible trajectories.[6]

As New York City was the center of literary publishing and vanguard visual art, and Hollywood was the developing locus of cinematic production, Chicago became the nation's leading center of commercial image printing. The demands of image circulation and expediency of distribution of finished products from a central point re-centered this form of cultural production from Europe and the American east coast to the upper Midwest. Histories of twentieth century American culture have often privileged accounts of modernist movements in New York and Hollywood's

hegemonic presence in cinematic mass-culture above the cultural production of Chicago, viewing the city literally in the center of the country as marginal. But what do we see when we attend to that center and its image manufactory?

Hortense Powdermaker's pioneering anthropological study of Hollywood announced that its "mass production of fabricated daydreams" represents the "first popular art to become a big business with mass production and mass distribution" (1950, 39). This isn't precisely true, given the prior history of printed images, particularly postcards. But priority claims aside, her analysis is helpful in identifying the importance of mass audiences. She quotes a Hollywood insider who had researched popular opinion regarding the movies, finding that "The Hollywood belief that there is a difference between the big-town and small-town market is an absolute myth. A gas station attendant in Sydney, Nebraska had the same approach to the same badly made melodrama as a haberdasher in the Chicago Loop" (Powdermaker 1950, 46). That unified market for films was exactly the target audience for postcards as well. Like films, they did the work of presentation of the world near and far. But they did so in a far more intimate manner, literally coming into the homes of their viewers, for collecting, preserving and re-encountering at will. Postcards thus had the potential for sustained presence in their consumers' lives in a way not possible for the time-based art of film.

The Teich plant was no less a dream factory than the Hollywood studios, but while in Hollywood "the industry" only meant one thing, Chicago was characterized by many industries, all visible and immediately to hand. Printing was loud, sometimes dangerous work involving volatile inks and heavy machinery. Image printing in Chicago took place in large factory spaces much like those where machinery and other commodities were produced, and it required skilled work forces, for whom image printing provided a solidly middle-class livelihood. The Teich Company plant at 1733–35 Irving Park Boulevard had specially reinforced floors designed to bear the enormous weight of its thundering presses and the tons of paper stock required to feed them, as well as the enormous windows prized by loft-dwellers today, to supply as much daylight as possible to enable the fine work by hand of the retouching department (Fig. 2.2). Different floors of the building were allocated to separate production functions, and tasks were differentiated according to gender.

Like many printing concerns, the Curt Teich Company's roots were in Germany, where its founder was born, and where the craft of printing had reached its highest level of sophistication in the late nineteenth century. Curt Teich trained as a lithographer before emigrating to the United States in 1895. Founded in 1898 with but three employees, his company grew to boast of 275 workers in twelve departments (Retouching, Photo-Litho., Engraving, Transfer, Art, Miehle, Offset, Composing, Bindery, House Department, Cutting and Shipping Department) occupying three floors covering a full city block, and housing five Miehle Presses, six Gordons, one vertical Miehle, five Scott, and two Harris Offsets (Curt Teich Company c. 1935).

Located in a then predominately German neighborhood, the Teich factory was embellished with large signs on its roof announcing the company's name, and direct access to a freight railroad line running along Ravenswood Avenue. Unlike commercial printing behemoth R.R. Donnelley & Sons on the city's South Side, the smaller Teich Company seems to have employed exclusively white workers for much of its history; both firms were emphatically non-union shops.[7]

Figure 2.2: Retouching Department, Curt Teich Company, c. 1920.

## Image and Process: From Photomechanical Reproduction to Commercial Display

The Teich Company used a number of photomechanical printing processes for postcards over the years, most derived from lithography. Chromolithography, developed in 1837, was a form of color-registered printing via lithographic stones. The photochrom process derived from it involved photographic transfer of a

(negative) camera image to a lithographic stone for printing—essentially, photochromolithography using a negative to harden a layer of bitumen to insolubility on a lithographic stone, in proportion to the light exposure received through the negative. Solvents removed the portions of bitumen not hardened, and the stone could then be inked. Photochroms gained their delicate chromatic splendor from between four and fourteen colors printed in registration, each from a separate stone. A proprietary photomechanical hybrid process, it was patented by Hans Jakob Schmid in Switzerland in the 1880s, and in the US, licensed exclusively to the Teich Company's greatest rival, the Detroit Publishing Company (Hughes 1994; Walter and Arqué 2014). Denied the right to use photochrom, the Teich company improvised CT-Photochrom, a process based on black halftone images overprinted with only four colors (Meikle 2016, 31). Those colors were applied to base monochrome images, and Teich agents would provide customers with a color chart resembling today's Pantone decks, to use in specifying hues for the tinting of their images. Up to 32 cards were printed grouped together at one time on Teich's sheet-fed presses, allowing the Teich Company to produce postcards in vaster quantity, if less elegant quality, than their competitor.

Although photographic images were the basis of these postcards, the final products represented interventions of the artist's hand upon the camera image, answering to demands of production, marketing or consumption. Beyond the inevitable photographic interventions of cropping and framing, the cards featured heavy retouching and interpolation of hand-drawn elements. Working toward a less demanding and more striking result, by 1931 Teich developed what they called CT Art-Colortone, a simplified five-color process employing more brilliant inks printed from more durable and lightweight zinc plates rather than lithographic stones (Newberry Library n.d.). This process was to form the basis for Teich's celebrated "linen" postcards, produced between 1931 and 1950. The texture (apparent in Fig. 2.1) was pleasing to the touch, but also expedient in serving to conceal the low-quality paper used for the cards, and the relatively low image resolution of the 125-line per inch printing screens employed. This process allied its products with the long pre-photographic traditions and practices of the lithographic printing industry, whose products spanned the range from fine art to inexpensive ephemera. Most evidently, the cheerful pastel tints of the process result in a color palette immediately recognizable, though rare in reality, rather like Wordsworth's description of a painting by George Beaumont:

> Ah, then, if mine had been the Painter's hand,
> To express what then I saw; and add the gleam,
> The light that never was, on sea or land,
> The consecration and the Poet's dream. (1807)

This tinting resembled the colorization of classic black and white films, in that all of the hues were assigned rather than recorded with the making of the original image.

Imagine the craftsmen at what the Company called "postcard headquarters" working at the rows of big tables in the Retouching Department, rendering the colors and tones of a New England coastal landscape or a view of the Grand Canyon, applying that look of the 'light that never was' to landscapes they'd never seen. The photographers and retouching colorists didn't meet or consult in the case of the Teich Company's products, whereas at the rival Detroit Publishing Company, classic negatives of scenes of the American West from decades earlier by renowned landscape photographer William Henry Jackson were translated into photochrom postcards under his supervision (Hales 1996). At Teich, by contrast, image-making was almost entirely subsumed into the production work (McElroy 2015). The brand was all—it was Curt Teich's name that was emblazoned on many of the company's products, and yet much of the company's business lay in producing cards for other distributors to market under their own imprimaturs, or for clients large and small, including manufacturers of practically everything, celebrated travel entrepreneur Fred Harvey, and innumerable hotels—each concerned with its own branding rather than with that of their image purveyor. Such clients were often highly exacting in requirements, which ranged from matching reality to transforming it. A furniture manufacturer might send fabric samples to insure the appropriate rendering of upholstery, or a shop proprietor might request the removal of rival businesses' signs obscuring his premises' façade.

As Meikle explains, a photographer or agent sent an image to Teich with color notes, then:

> In the company's art department, an airbrush artist retouched the photo by cropping, removing undesirable features, adding desirable ones, and in general sharpening and clarifying the image. Working with a halftone produced from this airbrushed photograph, a colorist then prepared a postcard-sized watercolor proof to be sent to the client for approval. At the plant in Chicago, printing plates for offset lithography were prepared in four colors—the primaries, red, yellow and blue, plus an additional dark blue which contributed a dramatic sense of depth. (Meikle 2009, 114)

Postproduction transformation of source photographs was routine. For a card representing a view of Lover's Leap and the Narrows from Wills Mountain Inn, Cumberland MD, for instance, the directions read: "THE NATIONAL HIGHWAY SHOWS UP BLACK. RUNNING ALONG SIDE OF THE STREAM OF WATER, PLEASE MAKE SAME SHOW UP LIGHT. ADD MAN OR TWO ON TOP OF LEAP" (Fig. 2.3). Adding figures to landscapes and tidying up compositions was all in

a day's work for the Retouching Department.[8] It could produce clouds, change weather, summon the moon and even turn day into night.

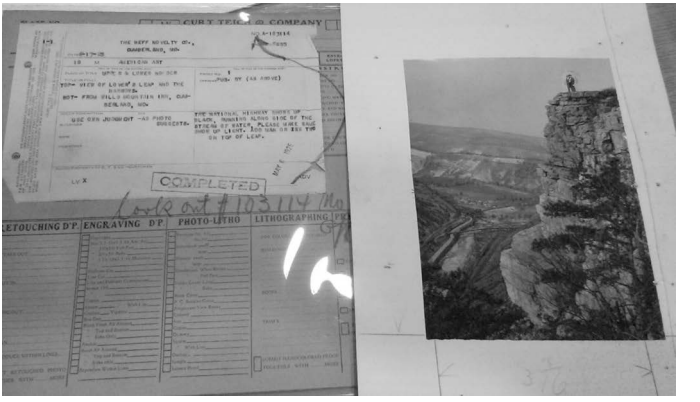


Figure 2.3: Job envelope, information sheet and retouched proof for *View of Lover's Leap and the Narrows, from Wills Mountain Inn, Cumberland MD*, 1925.

It is a small marvel of historical chance that many thousands of the chatty and jaunty production and retouching instructions that circulated through the Teich factory are preserved today at the Newberry Library. The company kept these notes following each print run, since the jobs only became profitable upon repeat orders, with the files available to direct production of subsequent editions as needed. Instructions were often conveyed on Teich Company "House Telegram" forms, boldly printed "Think intelligently" and "Act quickly" in their upper corners. These instructions can be assembled into a found poem about the appearance of the world and the printers' mastery over it:

> "Put in canoe or two." "Put flag on poles, add some fellows in gray-blue uniforms." "Take out island in distance." "Put in about 3 yellow cabs parked along sidewalk." "Strengthen the mountain view, a little if possible." "Particular Customer, cards to be first class." "Bronze turkeys are black with greenish tinge, white stripes in tail, red comb and wattle. Some turkeys are pure white, others are mostly white with light brown, on back from head to about wings. All, of course have the red comb and wattle." "Close all the open windows and add more sidewalk on the corner." "Show a little red in the Gasoline pump and take out the sign on building as indicated. For the street use a color that will be O.K. in your judgement." "Mr. Miller says he wants the words Miller Fireproof Storage imprinted across the door of the vault. Just make these letters on the photograph so they will appear on the plate." "On the view of the Swimming Pool, please change the color of the two light blue

> bathing suits on the two men in the view to Navy blue." "More color in lamp shades. Try to hold art work down to lowest possible figure." "Color of building—like No. 9 on color chart. Perhaps a wee bit lighter." (Curt Teich Company 1910–1940)

In making postcards, Teich retouchers took accurate and information-rich photographs and progressively introduced distortion to their syntax. Cropped, captioned, re-touched, colorized and given faux-linen surfaces, they functioned as raw material for a set of transformations. The final decisions in the Teich retouching room were repeated and circulated with a high degree of exactitude and uniformity, but those visual ideas and images were only arrived at through adulteration of the original camera pictures.


Figure 2.4: Curt Teich Company, Appointment card for sales representatives, 1920s.

The trajectories of images in the process of transformation to postcard format were bi-directional. Individual postcard consumers and collectors could not ac-

quire cards unless retailers stocked them from the manufacturers, of course, but first photographs were made somewhere and shipped to the factory in Chicago. Print runs of cards were produced and sent to distributors, who then displayed them to potential purchasers. Profit margins at the Teich Company for individual cards were slender and the teams of sales representatives were paid on a commission basis. Numerous booklets exhorted them to greater achievements in pushing the product. These documents represent the company's marketing to its own sales force, as when "Sales Pointers" exhorted: "The only true test of advertising is to 'Say it with orders'" (Curt Teich Company c. 1935, n.p.).

A special version of the card depicting "postcard headquarters" was developed for staff to send to prospective clients, announcing imminent sales calls (Fig. 2.4). In addition to producing its own vast inventory of scenic postcards to sell to retailers and wholesalers, it solicited orders from clients who used postcards in their own promotion. An undated document headed "POST CARD CHECK LIST" has four headings under which various points of advice for such clients are offered:

> Determine When Your Landscaping Will Be Best for Photography (What time of year will flowers and foliage be best?)
> Obtaining a Photographer (Ask locally who is best—the better your transparency—the better the finished cards.)
> Taking the Transparency (Go with photographer as he takes picture. Look through his camera so you know what he is including. . . . and that no cars are prominently shown in the view as they date your card.)
> Composition (An attractive view of a part of your building often is better than trying to include every unit.) (Curt Teich Company 1940s, n.p.)

The Teich sales manual also advised salesmen on how to pitch vending display strategies to their clients.

> The art and science of psychological post card display is a study in itself. We here at post card headquarters, however, will be glad to offer concrete suggestions for such effective displays for any one of your dealers if you will simply make your request known to us. (Curt Teich Company c. 1935, n.p.)

The company also marketed postcard dispensing machines, albums and racks. Sales methods were carefully standardized and scripted to build demand:

> IN POST CARD ALBUM NO. 1, mount samples of those subjects you can supply to your trade out of your stock. Present one of these albums to each of your customers and prospective customers so they have a constant catalog on hand from which to make their own selections—so they can order direct of you by phone or mail. Keep your trade informed of all new subjects, service them with suggestions that will help them to sell more post cards and folders by making known to them that

> at all times the latest developments in merchandising, displays, contests, educational values, and the like. They appreciate it—they sell more—you derive a larger volume of business from their stores. (Curt Teich Company c. 1935, n.p.)

From factory production to marketing by Teich sales staff, to retail sales and consumer selection was a long chain of commercial relationships, a series of trajectories forming a larger arc of production to consumption. This arc resulted in literally millions of postcard images over half a century or so of intensive production, a ubiquity that enabled postcards to achieve enduring cultural resonance.

## Representational Standardization: Encyclopedias and Microcosms in the City at the Center of the Continent

The Teich Company effectively represented the entire United States by means of postcard views of every landscape and municipality, marketing those views by means of a network of middle-men who promoted distribution of postcard views as well as touting for orders for cards of new subjects. They developed the broadest possible audiences for postcard images, which standardized topography into a system of representation in which the familiar and the alluringly unfamiliar, the known and the foreign all have their places. The drive toward encyclopedic representation, the impulse to map the known world, and the development of an orderly microcosm of systematized representation were already characteristic Chicago endeavors. The World's Columbian Exposition of 1893, like all world's fairs, constructed a symbolic microcosm on a single site, bringing the world to Chicago and linking Chicago to the world, but that was only the most prominent of the encyclopedic/microcosmic endeavors in the city. The growing cartographic empire of Rand McNally, Inc—like the Teich Company—was essentially a printing firm which chose to specialize in a particular category of production, literally mapping the world (Ackerman 1993). Donnelley and Sons, by contrast, chose to pursue the broadest possible spectrum of business, which included printing the *Encyclopedia Britannica* and the Montgomery Ward and Sears Roebuck mail order catalogs—themselves encyclopedic enterprises. The city at the center of the continent busied itself reducing the universe to orderly systems of representation for commerce, edification, communication and tourism, in the process becoming the locus for the reproduction, packaging and dissemination of imaged experiences of other places. Another approach to encompassing worlds was evident in Narcissa Niblack Thorne's construction of dozens of 1/12$^{th}$ scale rooms perfectly representing different styles and periods of American interiors, like dollhouse rooms without inhabitants.[9]

The encyclopedic corpus of Curt Teich Company cards is highly conventionalized—the angled views of Anytown USA Main Streets, the vertiginous rise of mighty urban towers, the truncated perspectives of hotel lobby interiors, and the picturesque beauty spots reflecting landscape compositional strategies long ago perfected by academic artists. The making of views that could fit these templates required only moderate competence in photographic execution, buttressed by the certainty that errors and lacunae could be remedied at the Teich plant. It was in their accumulated totality that these images gained purchase upon the imagination (Meikle 2000, 271). The Teich Company's postcard representation of the world is a microcosmic and an anti-cartographic pursuit. Maps display the relations of here, there and wherever, whereas the postcard picture of the world is disjunctive and accumulative, showing heres and theres but not the connections between them. The gaps in between postcard images are filled by imaginative projection, which solves the problem of scale posited in Jorge Luis Borges' famous story about a "Map of the Empire whose size was that of the Empire, and which coincided point for point with it" (1999, 325). Teich postcards described the city, and brought the nation into the city for reproduction, using ambitious image-marketing strategies and circulation resources to do so. Images did not merely circulate within the city, they also contributed to fashioning and refashioning networks of senders and recipients, as well as individuals' relations to the known and the imagined world.

Although image production was the work of the metropolis, small towns and sites of natural beauty or wonder were also often the subject matter of postcards rolling off the presses in Chicago, just as they were of Hollywood's productions (Levy 1990). A training manual published by the Curt Teich Company for its sales representatives announced: "COMMUNITY VANITY IS A VULNERABLE THING," continuing:

> No town is too small for an edition of colorful post cards showing the attractions of its community. Although it be located five miles from a railroad and perhaps ten miles from a main highway, there is something in that town that will attract people to it—tourists, motorists, vacationists and every one of those people is a potential buyer of souvenir post cards. (Curt Teich Company c. 1935, 3)

Sinclair Lewis's *Main Street* celebrated and savaged life in just such small towns ten miles from the highway, much like a postcard album brought to life and pored over by a sensitive collector of vicarious experiences. But while Lewis (1920) viewed the small town from the point of view of its own inhabitants, the viewpoint of the postcard is that of the traveler passing through, summing up the site and codifying it as a "view." Nondescript hamlets of little interest to the world were dignified by assimilation to the postcard view template, while scenes of sublime drama were domesticated, as is apparent in *Sunset Route, Mile Creek Canyon*, where a Texas-scaled sublime landscape becomes comfortably picturesque (Fig. 2.5). When composition

alone was insufficient to reconfigure a scene as postcard picturesque, of course retouching could do the rest, as in the card where the mighty Super Chief train dominates an orchard whose lush fruit owes everything to the skill of the Teich staff, who also supplied the modestly toy-like mountain peak in the distance (Fig. 2.6).



Figure 2.5 (left): Curt Teich Company, *Sunset Route, Mile Creek Canyon. Crossed Three Miles East of Langtry, Texas*, 1908.
Figure 2.6 (right): Curt Teich Company, *506—Santa Fe's "Super Chief" Traveling thru the Orange Groves, California*, 1940.

Postcards didn't seek to shatter or overturn existing world views, they codified them. The Teich picture of the world reflected the identities and values of its producers, as well as the social hierarchies, exclusions and presumptions that governed middle-class and corporate America. Thus, the postcard world is essentially a presumptively white, male middle-class world that valorized mobility. Yet it was also designed to appeal to audiences without that mobility—binding together metropolitan and provincial audiences—and it offered views of the world to everyone willing to consume them. The "lazy card's" condescension to both subject and sender, the conventional stereotypes of Native Americans, and the obsessive presentation of Black bodies as comic and inferior would have been offered for sale side by side with more anodyne views of main streets and beauty spots.[10] It was the purchaser's choice to consume and circulate racialized caricatures, to affirm the orderly expanses of wheat fields and small-town America, or to do both. Postcard images are fragments of the world to be appropriated, circulated, repurposed in one's own voice, or assimilated to one's own memory.

Like all mass cultural ephemera preserved in sufficient quantity, postcards do an excellent job of showing the views and values, emphases and omissions, reports and fictions, recognitions and misunderstandings of their time. Certainly, the structure of the Teich Company's postcard production replicated the order and hierarchy of power in society, but the claim of colonization is excessive. Exploring

the forms of selectivity, agency and repurposing of mass-produced images by individuals, and the inscription upon circulated postcards may provide unexpected insights. Important work remains to be done on the use and preservation of postcards by individuals.

## Dissemination, (Re-)Collection and the Past

Teich Company workers produced what would become commodities for purchase, either by someone who had viewed that scene itself and wished to remember it, or by purchasers traveling nearby a location where postcards of the scene were for sale, who may or may not have experienced the place. Appadurai's insistence that rather than "some kind of spatial landscape against which time writes its story," it is "historical agents, institutions, actors, powers that make the geography" and François Brunet's claim that "any history of art is bound to be a geography" apply as well to the ways in which the Curt Teich Company postcards frame an early 20th century American imaginary (Appadurai 2010, 9; Brunet 12). This is also true of their shaping of collective memory of place and the production of locality. While David Prochaska sees the postcard industry as organized to produce a visual archive of the entire world—"the illusion of archival totality"—we can include postcard purchasers, recipients and collectors in their trajectories of meaning as well (2001, 391). Roughly synchronous with the rise of snapshot photography, the postcard and snapshot categories matched each other like mirror images; the private, home-made and individual becomes public, mass produced and formulaic. Postcards are not facsimiles of what you yourself have experienced in the way that your own snapshots purport to be. Sometimes they are tokens purchased in lieu of one's own experience of place rather than as souvenirs of it, or as even surrogates for an experience the recipient of the card has not had, sent to indicate "You are not here" as much as "Wish you were here." The postcards were typically mailed to someone else far away, who presumably had not seen the imaged site either, and perhaps saved and passed on to future generations of postcard collectors, thus making a complicated journey away from the point of origin, and through a high degree of stylization, imagination, and expectation, forming a chain of production, circulation, inscription and consumption.

Deltiology—the practice of postcard collection and study—shares the vicariousness and obsessiveness of the related pursuit of philately. In both cases, two things are important: the immensity of a production expressive of encyclopedic aspirations, and the individuality of any one example as you hold it in your hands—the materiality, modesty, intimacy of the image, and its role as a messenger between individuals. There is near-infinite potential for freedom in the circulation and consumption of postcards. The card is mass-produced, but the experience of selecting,

inscribing, sending or saving the card is deeply individual and subjective. Postcards represent the place you've been, the place you haven't been but imagine, the place you claim to have been, all the places you could be. They produce a nearly seamless representation of the world—encyclopedic, complete, yet able to accommodate aberration and eccentricity, to include not only celebrations of place and identity but also expressions of contempt, curiosity and fantasy.

The private use and collection of postcards are inextricably linked to producing a collective memory and the past of a nation. Postcard images' accumulative, iterative imaging of both Main Street America and of its outstanding sights amounts to a body of historical record and a visual index to the beliefs and preoccupations of American culture. Jefferson R. Burdick, probably the greatest collector of printed ephemera of the twentieth century wrote:

> A Card Collection is a magic carpet that takes you away from work-a-day cares to havens of relaxing quietude where you can relive the pleasures and adventures of a past day—brought to life in vivid pictures and prose. Here is a phase of our heritage without which history has no full meaning, and only history can help men understand the past and prepare for the future. This is history from an original source. . . . History is not alone a record of world-shaking events. It is also a remembrance of the smaller things . . . . (1967, 6)

Burdick's view of the card collection as a resource for escapism and of the past as a haven would seem to exclude precisely the questions of violence, racism, injustice and colonialism that preoccupy many postcard scholars of today. But his emphasis upon the remembrance of smaller things opens the door to a near-infinite subjectivity of point of view, given that postcard collecting appealed to far wider audiences than merely the white, middle-class nuclear family. The vast inclusiveness of postcard representation actually attests to whatever the opposite of "havens of quietude" would be, offering broader potential for imaginative claiming, contestation, reinterpretation and engagement with world.

Van Wyck Brooks mourned the fact that modern American society had inherited no immediately discernable "cumulative culture" that could be "placed at the service of the future"—in effect, that it lacked a version of Burdick's magic carpet (1918, 340). Yet what if the cumulative culture was not diachronic and sedimentary, but explosively mass-produced, and everywhere to hand, following multiple trajectories through time and space, accompanied by inscriptions—in short, a postcard culture? The pervasiveness and vast production of photo-mechanically printed ephemera, permeating virtually every household in the land, can be framed as the foundation for a visual collective memory. As Brooks was codifying the idea of the American search for a "usable past," Curt Teich postcard imaging of both American landmarks and of the Main Streets of small towns was creating a kind of usable present that organized and conventionalized imagination of the nation and the

world beyond. Although some critics consider postcards nostalgia concretized, the period when those images were being codified and mass-produced was also that of the development of landscapes as sites of tourism and of cities and towns as noteworthy population centers, such that both subject and representation were in the flux of becoming at the same time. Postcards are often analyzed as raw material for social history and geography, but shifting emphasis to their production and circulation redirects our attention to their audiences, and their assimilation into everyday life (Webb and Geary 1998; Prochaska 1991).

Brooks' usable past has given way to the newer concept of collective memory, which emphasizes experiences undergone rather than values excavated or created. Discussions of collective memory have developed beyond Durkheim and Halbwachs' original conception of the reservoir of knowledge shared among members of a particular social group to emphasize society's memorialization of historical events, particularly tragedies, and the roles played by media images in shaping collective memory for generational cohorts (Young, 1997). Jeffrey Andrew Barash focuses (2016) upon mass media's transmission and selection of current events with the result of imbuing them with larger cultural significances. Keren Tenenboim-Weinblatt and Christian Baden argue that collective memory "must be widely disseminated and appropriated by individuals in a group to ensure mutual awareness. As a consequence, collective memory exists in the shared and private imagination of people, and is represented in the texts, practices, and artifacts of a group" (2016, n.p.). Collective memory thus construes group recollection of the past through the perspective of the present, and in relation to the needs of the present moment, an active construction of the past pertaining not to the individual unconscious, but to broad societal imperatives such as postcards' accretive, iterative imaging of the world, amounting to a body of historical record and an index to the preoccupations of American culture. Those preoccupations have changed with passing time, introducing new points of fascination in this vast historical image horde.

By its nature, photography puts circles and rectangles around reality, slicing image from context, and so emphasizes the world outside oneself. Teich Company postcards concentrated on surveying the breadth of the world from the viewpoint of provincial observers yearning for whatever is to be found beyond the immediate horizon, building expectations for the experience of seeing that world in advance, and creating imaginative trajectories that might one day be followed by actual travel. At once multiply authored and effectively authorless image-objects, cheap, ephemeral, consumable, postcards were literally vehicles for the inscription of messages and meanings by purchasers, transmitters and receivers. Ultimately, it is in their circulation and ubiquity that their significance lies, and it is these factors which position the universe of photographic postcard production as a viable collective memory, as full of lacunae, contradictions, troubling revelations and unacknowledged desires as any individual's memory must be.

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## Notes

1 Portions of this essay were presented in the American Art and Visual Culture Seminar at the Newberry Library in 2018 and in the NEH summer institute "Making Modernism: Literature and Culture in Chicago" at the Newberry Library, summer 2019. I am grateful to my fellow participants in both forums for their comments and suggestions.

2 The archive of the Curt Teich Company is today housed in the Newberry Library, Chicago.

3 Today considered emblems of mid-century American tourism, the "Greetings from" cards in fact originated much earlier, and in Germany. For more on "Grüsse Aus" cards, see Confino 1997, 181.

4 Carl Sandburg's 1916 poem "Chicago" opens with these lines:
Hog Butcher for the World,
Tool Maker, Stacker of Wheat,
Player with Railroads and the Nation's Freight Handler;
Stormy, husky, brawling,
City of the Big Shoulders

5 Baker notes that the average Chicago printer employed roughly twice the number of workers as the average New York printer. A contemporary study of labor arrangements in the Chicago printing industry is Brown's *Book and Job Printing in Chicago* (1931). Grehl points out that: "Although Chicago has never been a major center for literary publishing, it was important in trade publishing, and particularly in trade magazines and direct-mail sales from the 1860s onward. Starting in the 1920s, Chicago's large, versatile plants and edge in shipping rates lured major magazine accounts away from other regions." (2013, 156)

6 Although Brunet is more concerned with the relatively limited circulation of fine art works, his arguments are also relevant to printed ephemera existing in vast quantity.

7 The comprehensive R.R. Donnelley & Sons corporate archive is housed at the University of Chicago Special Collections Library.
8 This interventionist approach to the interpretation of images from source negatives was also true of the Detroit Photographic Company (Handy 2001).
9 The Thorne miniature rooms are now displayed in the Art Institute of Chicago.
10 One topic requiring further investigation is the tendency of racialized caricature cards to drawn rather than indexically captured imagery (see Sheehan, 2018).

# 3. Techniques of Transmission: Wire Service Photography and the Digital Image

*Jonathan L. Dentler*

Beginning in the 1920s, wire photography services decisively reshaped modern visual culture by using a type of photo-electric scanning technology similar to a fax machine to separate visual information from its material support, transmitting it through telecommunications infrastructure. These news organizations used an international business and telecommunications network to make visual information travel via radio waves and telephone wires as fast as text had been able to since the advent of telegraphy. Wire photography's history reveals that from the early twentieth century onward, radio and telephone were not just textual and aural media but visual media as well, and that there is a longer history to the image as data before the so-called "digital age." In fact, wire photography deployed both "analog" and "digital" techniques to facilitate the mobility of images, translating pictures into electromagnetic waves and then reconstituting that data as news pictures at their destination. Many aspects of "digital" images or the "digital era," I suggest, are not due to any underlying ontology of the digital, but rather to the fact that such images are translated and transported through telecommunications infrastructure, a feature they share with nominally "analog" wire photos.

In recent years, a number of scholars have worked to expand our view of photography with an eye to the way it is tied into infrastructural systems (Hill 2019; Gürsel 2016). In addition, more work has begun to show that well before wire photography, the medium was always bound up with transportation and communication (Leonardi and Natale 2018; Batchen 2006). Attention to infrastructure can help move us beyond discussions about photography's ontology as a medium and toward a notion of photography as an "apparatus" that extends beyond the camera, film, print, or photographer to the larger social, spatial, and temporal contexts and structures in which these are viewed and received (Solomon-Godeau 2007, 268–269). For example, the artist, researcher, and documentarian Susan Schuppli has argued that Nick Ut's iconic 1972 photo of Thi Kim Phuc running, naked and burned by napalm, was not simply the result of a fortuitously-timed click of the camera shutter. Crucially, it was also produced through the extended human and technical network that transmitted the picture by radio from Saigon back to the US.

Schuppli calls for scholars to excavate the technical procedures that underlie iconic photographs such as Ut's, since they tend to appear "seemingly unencumbered by the complex procedures out of which they emerged—a view now heightened by the immediacy of digital image production" (2014, 146–147). Detailing such procedures of data translation, transmission, and dissemination helps to disturb notions of photography's indexical and apparently unmediated "eye witnessing" power. It also reveals how the photographic image emerges out of an expanded field of entangled social relations, networks, and technical infrastructures.

Wire photography's logistical network included both human and technical interventions in the image. These interventions involved digital and analog, indexical and iconic, and autographic as well as allographic operations (Goodman 1968, 113–122, 159–164).[1] Digital and analog modes of representation are not fixed but complementary and dialectical. Crucially for this essay, "the mutual, reversible translation between the two formats is essential to their practical uses" (Mitchell 2015, 57). This was certainly true for wire photography, which translated between analog and digital formats repeatedly in order to produce, transmit, and display visual data. It was at once an apparatus, an electrical signal, the communications infrastructure upon which that signal depended, and a number of different possible material substrates for the display of the transmitted image, from daily newspapers to gelatin-silver prints and to higher quality magazine publications. It was also various practices for reworking that signal by hand using ink and pen once it had been recorded on the photographic substrate.

A better understanding of wire photography therefore contributes to a growing body of scholarship that is reevaluating the role of indexicality in the construction of photographic "facts." Communications scholars Robert Hariman and John Lucaites have argued that digitization is helping us to see analog photography anew, and making an older discourse that characterized photography as a discrete medium by its indexicality seem exhausted (2016, 10–11). New accounts of photographic indexicality no longer treat it as an ontologized feature of the medium but as an open-ended, and above all historical framework for talking and thinking about photographs (Bear 2018). Photographic indexicality is not the same thing as simple communicative transparency, for it always depends on a historically situated viewer who interprets the indexical sign, and, in the case of news photography, a public sphere in which the picture circulates and this interpretation takes place (Paulsen 2013; Azoulay 2008; Gervais 2016; Hariman and Lucaites 2016). Moving beyond optical recording technologies to take account of how visual records are transported across space can enrich our understanding of the objects that constitute fields such as visual studies and photography studies (Schwartz 2017, 104).

In a number of ways, the history of wire photography both clarifies and complicates the emergence of a visual regime that we now associate with computer-processed digital images. Long before microprocessors, handheld mobile devices,

and fiber-optic cable, the cultural concerns around wire photography evinced many of the themes that characterize more contemporary critical discourse on visual culture in the wake of digital image processing. For instance, artist and theorist Hito Steyerl has called attention to the "poor image" as a ubiquitous part of the Internet's visual landscape (2009, 1). While Steyerl focuses on how digital images degrade as a result of recirculation and compression, wire photography also hurtled "poor images" around the world at high velocity during press photography's analog era. Until certain technical challenges were overcome, wire and radio photography transmission processes blurred edges and caused middle tones to drop out of the photographic image. On the receiving end, newsroom artists often had to step in to retouch the image with pen, ink, and brush, in order to salvage visual information that was distorted in transmission. Their analog or autographic reworking was often clearly visible in the halftone dot matrix reproduced in the newspaper.

In this silver gelatin print of an Associated Press (AP) picture transmission from May 7, 1932 (Fig. 3.1), for example, the wire service art department's ink and pen work are clearly visible. Seven figures are set against a dark-gray ground completely void of visual detail—it has been inked over so that the background did not clutter the transmission and distract from the main action. The figures' facial features have been bolstered with an ink pen in order to add contrast for the halftone reproduction process. The digits of their hands and the edges of their figures have been likewise sharpened. Yet, in other parts of the image—the gendarme's jacket and medals, the suit of the figure on the far right, the faces of the three men in the top-left—pixelization resulting from the "Bartlane" transmission process via undersea cable to NewYork is still discernible. The picture caption supplied by the AP and pasted to the verso informs the reader that this is a "Bartlane picture rushed from Paris to London, then transmitted by cable to New York," showing police and attendants carrying President Paul Doumer out of the Rothschild Foundation mansion, where he had just been mortally wounded by a "Russian fanatic." In case they could not see for themselves, it includes a note for newspaper editors informing them that "this picture has been slightly retouched."

This print was thus made initially by a photographic process in Paris, likely flown to London, transmitted via undersea cable using a digital process, printed and retouched in the AP's New York art department, then sent out over the AP's North American wire photo network through an analog scanning process. After reaching newspaper editors, it might be retouched again and then put through the halftone matrix for reproduction on newsprint. Like other wire photos, it traveled and took shape through a series of translations or compression and decompression techniques between analog (film, print, raster scan) and digital (telegraph punch tape, halftone matrix) forms. In picturing the moment that Doumer's limp form was carried out of the mansion and into public view, it is also an image whose very formal details make visible the many techniques by which it was transported

beyond the moment of its production to a global public, along the paths traversed by planes, undersea cables, and telephone wires.

Figure 3.1: AP photo produced by "Bartlane" transmission process, depicting the immediate aftermath of President Paul Doumer's assassination in 1932.

## The Historical Advent of Wire Photography

If photography was always bound up with circulation and communication, wire photography's widespread adoption by the press in the early twentieth century represents the first time that large publics across the globe actually saw images that circulated as electrical information rather than solely as material objects. Following the advent of telegraphy in the nineteenth century, the duration involved in

communication ceased to be primarily a function of physical geographic distance (Carey 1989; Wenzlhuemer 2010, 24). Yet while these cables carried numerical and textual messages, images remained stubbornly tied to their material supports. Art historian Jennifer Roberts has argued that the advent of telegraphy in the nineteenth century made the visual arts conspicuously weighty and slow by comparison to words (2012, 12–35). Their materiality made pictures resistant to code and transmission.

Breakthroughs around the turn of the century such as the photovoltaic cell, however, allowed inventors to build picture telegraphy devices that could scan a picture using light instead of a mechanical stylus on chemically treated paper. The German inventor Arthur Korn produced such a model and it was even used to transmit some pictures for illustrated weekly magazines such as *L'Illustration*. Korn's device (Fig. 3.2) used a light to scan a picture attached to a rotating drum. The reflected light would be registered by a photovoltaic cell, which transmitted a current into a telegraph wire and carried it to a receiver, which would convert the signal back into light, exposing a negative attached to a synchronized rotating drum. The device could reliably transmit over considerable distances, but it was experimental and not suitable for mass production (Dussel 2012, 57; Pichler 2010). Furthermore, at that time daily newspapers were only just starting to replace sketch-drawings based on photographs with photographic reproduction using halftone matrices, and it would be about two more decades until photographs more fully displaced sketch reporting (Dussel 2012, 19; Zurier 2006, 155–156). True spot photography could only really be accomplished for local events, since transportation times by rail or steamship were too great. As Jason Hill has argued, from the beginning of wider halftone use around the turn of the century, the press had valued photography "insofar as it operated in concert with an evolving set of technologies and professional protocols, ensuring both the timely picture's initial production and the speediest translation of that image into the widest possible newsprint circulation" (2015, 193). This allowed the press to place "spot" pictures alongside the news itself when it came to local events, but very distant or transoceanic events were still hybrid combinations of halftones and artists' illustrations.

It was only in the years following the First World War that the infrastructural and organizational conditions began to be put in place to make national and international spot photography a reality. Specialized photo services such as the "Press Illustrated Service," "Pacific and Atlantic Photos," and "Wide World News Photos" began more consistently to supply American dailies with topical photographs, and expanded their operations across the Atlantic to Europe. As photo agencies increasingly developed geographically far-flung operations, as well as the organizational capacities and practices necessary to produce and distribute topical photography to newspapers quickly, the contours of a market for picture telecommunications began to take shape.

From that point on, the wired image began to bridge the gap that telegraphy had opened up between the textual and the visual. A new class of images emerged, whose visual qualities were measured, abstracted, transmitted, and reconstituted by telecommunications. Often this process involved translations between digital and analog formats in order to "compress," transport, and then visually enrich news images.

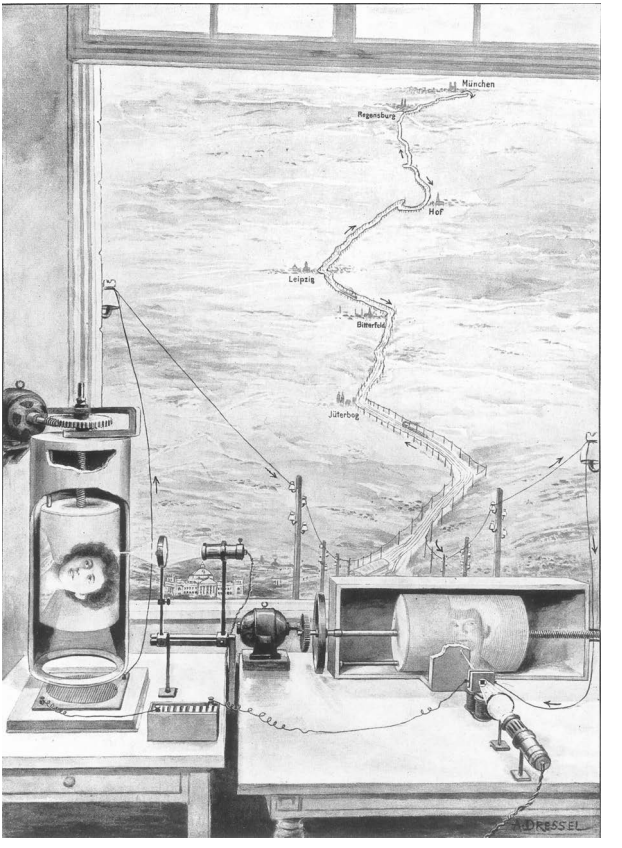


Figure 3.2: Korn device, drawing by A. Dressel, 1904.

## Journalistic Objectivity and the Evidence of Circulation

Digital photography has often been accused of undermining faith in photography's ability to represent the world, because it supposedly severs chemical photography's analogic, mechanically-guaranteed link to its referent. According to this view, "analog" photography has an indexical relation to what it represents (Mitchell 1992, 56; Ritchin 2009, 16–18). Yet while digital images often appear without any visible traces of their paths through fiber-optic cables, servers, and cell towers, wire photos tended to retain visible traces of their infrastructural routes on the picture surface itself. Wire photos therefore showed more than their original referent, revealing as well the "noise" introduced by their transmission and translation through different data formats. This fact complicates simplistic narratives according to which analog photography guaranteed journalistic objectivity and public trust in news images, while digital photography risks undermining that trust. Wire photography demonstrates that the history of photography does not divide cleanly into "analog" and "digital" eras, in which purely indexical copies were followed by manipulated images, separated from their referent as a result of digitization. As W. J. T. Mitchell has argued, the digitization of images must be examined on the basis of the actual empirical particulars of its social practice, not from "a thin description of the bare technical facts" (2015, 52). Prioritizing circulation reorients our understanding of photography away from a narrow focus on image capture and toward the ways that images have been translated between data formats in order to reach their viewers. Long before the "digital era," this process involved the introduction of "noise" into the picture's relation to its referent, as well as attempts to simulate its referent by means other than optical-chemical registration.

Examining how pictures formally registered their own movements through space in British colonial America and the U.S. in the eighteenth and nineteenth centuries, Jennifer Roberts has argued that "geography inhabits pictures" (2014, 2–3). While wire photography capitalized on its ability to separate images from their material supports as analog information, its images nevertheless visually registered the effects of their bumpy rides through circuits, electrical interference, and adverse weather patterns. By the 1930s, photojournalism textbooks even instructed photographers how to shoot photos that would transmit well, losing as little visual information as possible. One textbook, for example, advised the wire service photographer to shoot in higher contrast in order to avoid middle gray tones falling out in transmission. Like Roberts' pictures, then, wire photographs formally preprocessed the distances they were designed to span.

This fact complicated wire photos' relationship to journalistic objectivity, which, as Michael Schudson has argued, was being fully articulated during the 1920s at exactly the moment when the press began adapting wire photography on a large scale (2001, 160–162). In the nineteenth century, the commonly held

belief in photography's documentary capacity was already bound up with the evolving norm of journalistic objectivity, and photographic realism became a favored metaphor for describing journalistically crafted facts (Schiller 1982, 92; Muhlmann 2008, 13–14; Schudson 1978, 5–6). The widespread adoption of the halftone photo-mechanical reproduction process in the early twentieth century, with its ability to reproduce pictorial statements seemingly "without syntax," only hardened the association between photography and journalism's objectivity ideal.[2] The gradual adoption of the halftone boosted arguments for photography's epistemic virtue as an objective recording mechanism, against engravings' claims to superior interpretative powers (Raetzsch 2015, 301–306).

Accordingly, wire photography would appear no more than a logical next step in the way that journalism deployed photography to produce ostensibly objective representations while obscuring the subjective viewpoints and political interests of those who shape (and own) the news. As a "mechanical" transmission process, wire photography would seem to support the myth that news photos are unbiased copies of nature rather than motivated visual arguments that must be handled by human individuals and institutions. Communications scholar Barbie Zelizer has demonstrated that within daily newspaper journalism, wire photography faced a "discourse of resistance" from text-focused editors through at least the 1930s. Journalists discursively "disembodied" photographic technology, shoring up their professional status by casting news photography generally and wire photography in particular as merely an automatic, technology-driven, and artless supplement to real text-based news work (1995, 78–92).

Yet wire photographs were hardly mechanically-produced indexical documents that provided a transparent, window-like view onto world events. As I have already shown, they were put through various processes both analog and digital, and worked on by both machines and human hands. Given the halftone's importance in constructing journalistic objectivity, it would seem obvious that muddy, interference-streaked, and visibly retouched wire photos might trouble such a visual regime. Understanding this medium therefore extends much further into the twentieth century the long process of adjustment and hybridization during which the press deployed both hand illustration and photomechanical engraving processes to illustrate the news. Examining the slow adoption of the halftone in the French illustrated press during the last two decades of the nineteenth century, Thierry Gervais demonstrates that the process was one of "slow assimilation of photography into the illustrative process," in which illustrators produced "hybrid images" that were "halfway between artistic creation . . . and information" (2017, 86–91). Even into the early twentieth century, illustration practices did not disappear along with the engraver's studio. News images' credibility, Gervais argues, has always relied not just on photographic indexicality but also on a historically situated visual rhetoric that responds to both readers' changing beliefs in the truthfulness of images and their

viewing pleasure (2017, 92–97). Just as illustrators had long done, newsroom artists, even into the 1950s, continued to alter wire photos in order to salvage, simplify, and dramatize the image's visual information.

Rather than a bug, therefore, the wire photo's visual impoverishment could be a feature. Precisely because this "first impression" was hazy and indistinct, it simultaneously made something else visible: the infrastructural and logistical effort that undergirded photojournalism and reshaped global spatial relations. Wire photography was not simply a window through which audiences expected to see seemingly unmediated evidence of hitherto distant places and events within a new temporal horizon, although that was one of its most important tasks. As the "interface" at which people perceived and contemplated distant events by way of telecommunications infrastructure, wire photography provoked meditation on the condition of connectedness itself. In this sense, wire photography was part of a "vernacular modernism" that responded to and reflected upon the experience of modernity, particularly the condition of being connected by vast and invisible planetary infrastructural systems (Hansen 1999, 59). For Marshall McLuhan, the real "message" of any medium "is the change of scale or pace or pattern that it introduces into human affairs" ([1964] 1994, 8). Wire photography reorganized the senses by technically extending vision across space in a new way, transforming not only the visual culture of the news, but also the everyday experience of time and space.

## The Infrastructural Mediation of Time and Space

As the communications scholar James Carey argued, the most important impact of telegraphy was that for the first time it separated communication from transportation, and messages from the physical movement of objects (Carey 1989). Dematerialization freed visual information from the Newtonian laws that governed it when it travelled as an object (Wenzlhuemer 2007, 349–350). "Dematerialization" here simply refers to the fact that telecommunications infrastructure, while material, does not itself move in order to convey information but instead provides a new kind of path along which information travels. Infrastructure's materiality functions differently than the materiality of objects. The radio antennas, undersea cables, and electromagnetic waves that transported wired images were not themselves visible. They were only "echoed" in the traces that the transmission process left in the finished print or halftone, or the newsroom artist's efforts to hide those traces with pen, ink, and brush. Wire photography demands a shift of focus from the photographic object itself to the infrastructural ground that gives rise to particular objects.

Wire photographs' connotative meaning was strongly associated with the collapse of geographic distance brought about by new travel and communications

technologies. While they certainly produced meaning by way of icon-based communication, wire photographs also spoke to something more than their denotative content by making visible the infrastructural network that stretched across national, imperial, and regional boundaries. Wire photography's speed sutured viewers to a new geography and temporality, experienced as a simultaneously occurring global present. In this sense, what these pictures "meant" was less important than what they *did*, or the conditions they set for apprehending the world. As John Durham Peters has argued, media are not just devices for sending messages and information, they are also crucially "agencies of order," which constitute worlds by arranging the relations between things, time, and space (2015, 1). Media can be thought of productively as making *being* rather than *meaning*, as environments and habitats, or as ensembles of natural elements and human artifice that enable certain forms of life (Peters 2015, 3). In the long run, Peters argues, media have been more about the logistical infrastructures that order and constitute civilizations, cosmologies, and spatiotemporal schema. Digital media, with their many forms of communication and pervasive envelopment of daily life within media environments, have made it easier to see the twentieth century equation of media with communication and meaning as an aberration from the historical norm (2015, 5–7).

While contemporary observers often remarked that wire photography "annihilated" space and time, it would be more accurate to say that it produced a new kind of space and pace for those it connected. As it circulated and found a temporary home in various media, from silver-gelatin prints to offset posters to newsprint, the wired image sutured time to space in a new way, bringing the very far away closer in a condensed period of time. Such pictures gave audiences a measurement of time and space, and a sense of how the two were in flux at that historical juncture. As global historian Roland Wenzlhuemer has argued, space is essentially relative and always produced by relations between objects in a given system (2010, 19–47). While McLuhan famously argued that electric media were in the process of "abolishing both space and time" and creating a "global village," time and space cannot actually be annihilated ([1964] 1994, 3–5). Instead, communications infrastructure creates new spatial relations by articulating and connecting places, people, and things into new constellations. While wire photography seemed to "annihilate" space and time, it would be more accurate to say that it rearranged them, bringing media hubs such as New York, London, Berlin, and Tokyo closer together, while pushing areas outside the geography traced by its network relatively further away. This point is worth keeping in mind with regard to the contemporary so-called "digital divide," or the structural inequalities in access to digital communication technologies. While space and time remained foundational frameworks for experience, wire photography changed the ways they were given to sensation and perception, offering an interface that communicated about new spatial relations.[3]

As artifacts, wire photographs concretized and formalized the rapid shrinking of distances. Modern life depended in fundamental ways on an extensive infrastructure that remained below the threshold of visibility, and it was to the problem of this very threshold that wire photography was often addressed. Like media itself, infrastructure's typical mode is to withdraw from view, and it is frequently concealed by design (Peters 2015, 34–36). In general, today's digital infrastructure tends to catch our attention only when it breaks down. During the decades around the early to mid-twentieth century, however, fast images made telecommunications visible by registering traces of their transmission, and became part of a media ecology that helped spectators adjust to conditions of global connectedness. Pictures, which had taken weeks to travel across oceans by steamer, could now be transmitted and printed in daily newspapers. Social acceleration and the collapse of distance were at play connotatively in the experience of seeing and interpreting wire photos. In this respect, wire photography reached far beyond the indexical and evidentiary function credited to press photography during this period, when, it has been suggested, photographs were added to newspapers in order to shore up declining faith in textual reporting's objectivity (Schwartz, 1999).

## Toward a Deeper History of the Digital Image

When Charles Lindbergh landed at Le Bourget airport on May 21st 1927 (Fig. 3.3), the Pacific and Atlantic Photos agency rushed to transmit pictures of his arrival back to New York via undersea cable. Far from a sharp photographic image, many of its finer gray tones having fallen out as a result of the transmission process. The pixels resulting from the process in which the image was built up through a "digital" telegraphic punch tape are visible in this gelatin silver print. Yet its poor quality possessed a certain value for picture editors and spectators on the other side of the Atlantic, because it signified that this image was the very first to arrive. The "noise" introduced into the photo as a result of its transmission could become meaningful content. Specifically, the Lindbergh wire photo features a productive interplay between its denotative content—the flyer who has bridged space—and connotations of speed and acceleration accentuated by their formal lack of photographic sharpness and tonality. As a metaphor, the pilot visualized and materialized how wire photography services used telecommunications infrastructure to stitch, bind, and link distant places into a simultaneously unfolding present. In the interwar period, such images were visible proof of a new cultural geography produced via infrastructure. Wire photos were not just "reflections" of a prior political and industrial geography, but were productive of that geography as the point at which individuals perceived and contemplated it.

Figure 3.3: Lindbergh meeting French aviator, inventor, and engineer Louis Blériot, who had made the first flight across the English Channel in 1909. Photo transmitted using the Bartlane method by Pacific and Atlantic Photos.

The image was transmitted using the "Bartlane" process, a transmission technique by which a picture's tones were converted into a punched strip of telegraph paper for transmission and reconstitution into another picture. The case of the Bartlane image transmission system illustrates a longer history of the "digital" image, which was woven into image circulation and the visual culture of the news in the twentieth century. In 1918, H. G. Bartholomew, one of the editors of the London *Daily Mail*, and M.D. McFarlane, who had served in the British air force during the First World War, together began to develop the technology. They made transatlantic tests in 1920 during the International Yacht Race and in 1921 for the Jack Dempsey-Georges Carpentier boxing match in New Jersey (Coopersmith 2015, 49–51). Lord Northcliffe's *Daily Mirror*, which had a circulation of more than a million copies per day at that time, published the resulting pictures, but judged the system unsuitable for permanent commercial application. In 1924, the process garnered interest from the McKormick-Patterson newspaper syndicate's *New York Daily News* and *Chicago Tribune*, which supported further tests, and built a regular service between London, New York, and Chicago. In London, Bartholomew was in charge of European operations, while McFarlane ran operations in New York for Pacific and Atlantic Photos, the McKormick-Patterson syndicate's photo service.

At first, the translation of tonal values had to be made manually in a series of alphabetized values to be relayed into an image on the receiving end. However,

by 1924 the two engineers had worked out a system in which pictures could be automatically scanned and turned into punched tape (Fig. 3.4), transmitted, and then automatically reconstituted on the other end of the connection. Quality improved gradually, and by 1926 the system was in regular use. First, a photograph would be printed five times from the same negative onto small metal sheets with tonal variations. The metal prints were then placed on a series of rotating cylinders, each of which was traced by a needle with a current running through it. The needle was connected electrically to a tape perforator, which would punch holes in a telegraph tape according to the amount of current running through the needle from the metal plate. The plate's surface area conducted more or less electricity according to the light and shade of the image printed on it. The perforated tape would then be delivered by messenger to Western Union and transmitted as an ordinary cable message across the Atlantic. On the other end, the tape was taken to a Bartlane device and run through the reproduction apparatus, inside which a light was projected through the holes in the tape as it rapidly unspooled, registering on a photographic film and building up the image with pixels.

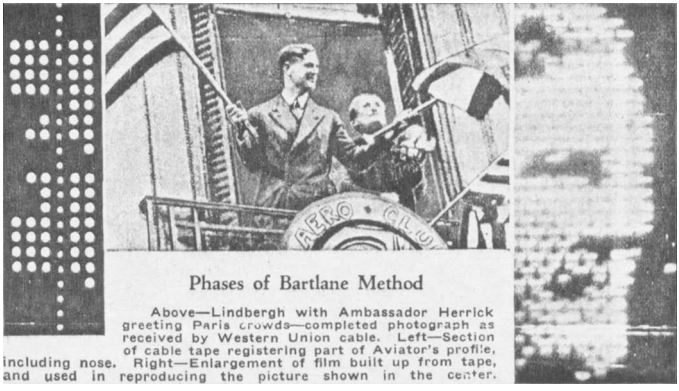


Figure 3.4: "How Photographs of Lindbergh Were Sent by Cable," July, 1927, *Dots and Dashes*, Vol. III, No. 7.

The Bartlane process underwent continual technical improvements and its use expanded in the interwar period. Yet, as "radiophoto" raster scanning and transmission improved, particularly during World War Two, Bartlane was eventually eclipsed by this "analog" image transmission technique. By the end of the war, the major wire photography services largely used synchronized radiophoto devices for overseas picture transmission. Bartlane's importance as a precursor to the computerized digital image, however, has not gone completely unappreciated. In their 1992 textbook *Digital Image Processing*, which has since gone through many editions,

Rafael Gonzalez and Richard Woods began by acknowledging that "one of the first applications of digital images was in the newspaper industry, when pictures were first sent by submarine cable between London and New York" (2002, 3). The Bartlane transmission system, they explained, had already formulated the basic mathematical definition for a digital image. That system defined the image as having two-dimensional *x* and *y* planes along with a certain number of discrete coordinate points, each having a definite amplitude value of gray-scale intensity. The two authors cited an article by McFarlane entitled "Digital Pictures Fifty Years Ago," from a 1972 issue of the *Proceedings of the IEEE* on digital picture processing. "Seated in a comfortable armchair watching live television from the moon," McFarlane had written, "it is hard to realize that in the early 1920s it took the better part of a week or more to get news pictures across the Atlantic" (1972, 768). The Bartlane system, he explained, had reduced this transmission period to mere hours by automatically translating a picture's tonal values into a digital record tape and reconverting that information into a picture.

At the same time, while the Bartlane system used digital images, it did not technically constitute digital image processing, which requires operations performed by a digital computer. The first computers powerful enough to carry out meaningful image processing tasks appeared in the early 1960s. Gonzalez and Wood trace this development primarily to the space program, and particularly to the Jet Propulsion Laboratory's use of computers to improve images transmitted from space probe missions beginning in 1959 (2002, 5). Yet even here, there is a connection to wire service photography. In a letter to McFarlane preserved in his archive, W. H. Pickering, who headed the JPL from 1954 until 1976, wrote:

> "Dear Mac,
> . . . It is indeed interesting to realize that many of the techniques you were using have been reapplied with modern instrumentation capabilities. If you ever get up to Pasadena, give me a call. I would be delighted to have you come out to the Laboratory to see some of our Mariner photographs."[4]

The two knew each other well, since McFarlane had worked for a number of electrical engineering firms in Southern California and at the California Institute of Technology in the 1950s, and Pickering had read McFarlane's article on the Bartlane process as a precursor to digital image processing in the *IEEE*. On July 14, 1965, Mariner 4 had taken twenty-one images of Mars, transmitting them digitally back to Earth at 33.3 bits per second.

The Bartlane method's real importance lay in the fact that it broke up the picture plane into discrete points with alphanumerical values tied to tonal values, and, crucially, that it did so in order to transport the image via telecommunications infrastructure, bringing photographically-informed pictures of faraway events to spectators within a new time scale. It had nothing to do with destroying chemical

photography's indexical link to the real, or with any attempt at forgery or manipulation. As the *Dots and Dashes* article on the Lindbergh photos insisted, these pictures were "actual photographs" transmitted over the Atlantic cables. Instead, Bartlane constituted a method of "compressing" the image into a more transportable format, one that could be built up again into a richer, denser, analog picture format on the receiving end, with the help of newsroom artists and their autographic techniques. As W. J. T. Mitchell has suggested, digital techniques have less to do with fakery than with the "optimization" of images, "crunching them down for screening or transmitting over the Internet, fattening them up in .tiff format to produce highly saturated color prints." Visually "poor" digital images might actually possess their own kind of realism, Mitchell argues, since they demonstrate a certain candor about the operations performed on them in order to enhance their functionality (2015, 50–51). The Bartlane method broke up images into a code in order to transport them more easily, while retaining some of the reality effects of chemical photography. Importantly, it did so in a specific historical, social, and institutional context: the wire photography services that produced, transported, and authenticated these images garnered public trust through the creation of, and adherence to certain journalistic norms that became increasingly formalized over time.

In addition, if the space program pioneered digital image processing, then wire photography services first made it an infrastructural reality for large numbers of people, long before personal computing or widespread Internet access. In the same year that the Mariner mission sent back digital images of Mars, the AP installed digital image processing technology into its global wire photography network for the first time. Rather than a way to capture, transmit, or store data, however, this digital image-processing unit automatically interfaced analog data coming from abroad with the North American domestic system and vice versa. Because international wire photo data standards were lower than those for the domestic U.S. system, prior to the digital interface's installation, photos had to be converted by making a hard copy on a receiver set in the incoming format, then retransmitting them in the correct outgoing format. This slowed down processing speed and degraded image quality.[5] The digital interface was thus a kind of "infrastructural patch," which made it possible to circulate pictures between continents without chemical-optical handling to translate between analog data formats.

Digital image processing, therefore, entered wire photography initially as a *network management solution* for the logistical problems that cropped up once the demands placed on the network had reached a volume that made its mode of transmitting visual information a drag on operations. Digital image processing's entry into wire service photography had nothing to do with manipulating images. Rather, it was another way of accelerating the processing and circulation of news images, continuing a development that had long been underway and taken both "digital" and "analog" forms. Digitalization crept into the infrastructural network step by

step rather than all at once, but its horizon was the vision of an increasingly frictionless image circulation system.

The digitization of various wire photography network processes not only helped circulate photos faster by cutting out laborious and time-consuming darkroom work, it also allowed pictures to move through the network more efficiently by smoothing logistical logjams. Once digital processes had entered certain key steps in the network, it was easy to envision the potential savings in time and labor that would result from its extension to new infrastructural links. In the early 1970s, the AP installed digital tape recorders to store photos coming off the computer interface, as part of the overall move away from intermediate handling of negatives, prints, and retransmissions. The wire service also began working with an MIT lab on computerized image editing and storage, and planned to roll out computer picture processing in regional hubs as the telephone companies extended digital transmission lines. The AP's Laserphoto brochure explained that the new system was the same method "used to refine pictures transmitted from the moon to earth."[6] The new system allowed editors to store limited numbers of photos on a hard drive, and to display them on a video monitor in order to select, discard, edit, transmit, or store them for later automatic dispatch. These computers also included basic graphic manipulation and editing functions that would normally be carried out in darkrooms, such as enlarging, cropping, ninety-degree rotation, tonal-curve alteration, and caption editing. United Press International (UPI) called its version of this early form of Photoshop "Digital Darkroom," while the AP called theirs "Electronic Darkroom," although of course the reference to a "darkroom" was an anachronistic remediation of an earlier form.

Crucially, the new system allowed editors to generate a queue for transmission over the network. This solved one of the analog wire photo network's major logistical and scheduling challenges. Previously, pictures had needed to be transmitted simultaneously over the whole network, or regional network branches. Newspaper editors received verbal descriptions of the picture over the telephone, and then had to either opt to receive or refuse it, sight-unseen. The new system allowed images to be stored, queued, and displayed for photo editors before they were transmitted. The queue, which included priority transmission lists and background lists, meant that picture transmission prioritization could be automated. Urgent spot photos could automatically take precedence without disrupting the whole schedule. The computer automatically converted the picture from analog data into digital data that it stored in its memory, available to be called up and manipulated on the video screen, then reconverted it into analog data to be sent out over the wire or radio networks to subscribers.

## Conclusion

Understanding wire photography demonstrates that the "digital" and the "analog" do not constitute the basis for neat historical periodization. The two modes of representation blend into one another and are both ways of compartmentalizing, presenting, and symbolizing. Wire photography involved various techniques for translating between these two modes in order to package news images as telecommunications information, coax them back into picture form, and reproduce them on newsprint. In the ostensibly indexical synchronized scanning wire photo, visual "noise" was frequently introduced into the resulting image, lending an additional element to the picture that affected its meaning by putting its content into play with its infrastructural route. Meanwhile, contemporary digital images often represent their referents much more clearly, without any perceptible noise or corruption at all. This certainly ought to give pause to simple distinctions between analog and digital photography on the basis of their "direct" and "indirect" relationships to the referent. Discussions of digital or analog photography ought not to focus on a narrowly technical description of image capture, but consider questions of circulation, formatting, and perception. By putting images into circulation through a telecommunications network, wire photography laid the groundwork for conceptualizing the aesthetic as information, long before computer-aided digital image processing. In the end, it may be that the image as an effect of telecommunications infrastructure is a more important historical transformation than any particular digital processing technique.

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## Notes

1 In *Languages of Art*, the American philosopher Nelson Goodman distinguished digital and analog systems, as well as allographic and autographic art forms. Goodman considered "digital" and "analog" to be somewhat misleading terms, and preferred to distinguish digital symbol systems as "differentiated" and

analog systems as "dense." Allographic arts were singular objects with claims to originality and thus susceptible to forgery, such as paintings, while autographic arts consisted in the production of a notational system, such as a literary text or a musical score, which could be reproduced exactly without any risk of forgery. Digital images, in this sense, seem "allographic," while the analog retouching done by newsroom artists would be an "autographic" form of mark making.

2 For William Ivins Jr., the longtime prints curator at the MET, looking back on the history of prints and visual communication from the mid-twentieth century, the halftone's revolutionary significance was that it implied "no preliminary syntactical analysis of the thing seen into lines and dots, and the ruled lines and dots of the process had fallen below the threshold of normal vision. Such lines and dots as were to be seen in the report had been provided by the thing seen and were not those of any syntactical analysis. . . . At last men had discovered a way to make visual reports in printer's ink without syntax, and without the distorting analyses of form that syntax necessitated" ([1953] 1969, 128).

3 As Wenzlhuemer puts it, "Our intellectual understanding of space can work only through the object . . . it is the object itself that allows us to intellectually handle the confounding abundance of spaces. It is the focal point at which spaces touch. And accordingly, the objects are the interfaces through which different spaces can interact with each other, impact on each other and influence our perception or concept of space." (2010, 29)

4 Pickering to McFarlane, August 2, 1972. AG23:1, McFarlane Papers, Volkerding Center for Creative Photography.

5 "Remodeled Wirephoto Gets Console," The AP World, Summer 1971. "Wirephoto's interface—the computer which translates the 70 rpm transmissions from abroad into 100 rpm signals for domestic distribution, and vice-versa—has been piped into the console. . . . The interface . . . provides automatic transmissions between foreign and domestic networks. . . . Without this device, quality would be lost through chemical processing and retransmitting and as much as 20 minutes delay could be experienced."

6 "Laserphoto—What does Digital Transmission mean?" 1973. AP Corporate Archives.

# 4. Calm Images: The Invisible Visual Culture of Digital Image Distribution

*Simon Rothöhler*

The visual culture of the present is not usually suspected of being a calm one. The omnipresence of digital images distributed via various social media platforms, messaging apps and streaming services is therefore rarely associated with qualities such as discretion or restraint. On the contrary, this culture is commonly assumed to be dominated by an excess of visibility, which, in the form of viral GIFs, memes, and selfies, is linked to the instantaneous nature of digital image distribution. The ease with which they are produced and their real-time communicative mobilization have turned images, like many other digital products, into a ubiquitous phenomenon with zero marginal costs (Rifkin 2014). Generating another image, distributing it immediately, and potentially sharing it with the whole world, or at least the whole digitally connected world, via social media transport channels, costs a smartphone owner virtually nothing, other than a casual touch of the screen and a minimal amount of energy—which can nonetheless be quantified, and like every search engine query, creates a carbon footprint (Ensmenger 2018; Elegant 2019).

The image-related growth rates are correspondingly spectacular, particularly in a historical comparison. Nicholas Mirzoeff has claimed that at present, in the US alone, more photographic images are being produced every two minutes than in the entire 19th century (Mirzoeff 2016). Other estimates (whose basis, apart from the verifiable sales figures for camera-equipped smartphones, is similarly unclear) assume that humans had put a total of 3.8 trillion photographic images into circulation up until the early 2010s, but added one trillion in 2015 alone (Kane and Pear 2016). Here, we should not overlook the fact that long before the digital present, the evolution of technical visual media was already accompanied by a discourse addressing the increasing volume of images in circulation with a semantics of cultural criticism and metaphors such as that of the "flood of images," as can be demonstrated with a paradigmatic quote from Lewis Mumford in 1952:

> 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 enough to call for attentive concentration. Now it is the actual experience that is rare, and the picture has become ubiquitous. (Mumford 1952, 96)

Whatever one's view of the assumed shifts in the economy of attention, there is no doubt that the proliferation of technologically generated images—"ubiquitous photography" (Hand 2012)—is virtually unlimited. And yet it is less possible than ever to use a mere analysis of the surfaces of visual culture—of phenomena materialized in pictorial form—to comprehend the resulting excess of visibility, which has led to massive reservoirs of digital images. We can argue here, with Claus Pias, that the reason for this lies in the nature of digital images, insofar as these can be clearly distinguished, in media technology terms, as images "that have information" (Pias 2003). We could rephrase the argument to say that digital images have a double existence, in a sense: firstly as data sets with which computers can carry out calculations, independent of their software-based transformation into visual output, i.e. beyond visual materialization, and secondly as a visual form that can be recognized and viewed as an image by human perceptions, which find non-processed image data rather uninformative—although this can only happen if the image data are mobilized pictorially by appropriate software. The pictorial nature of digital images is not simply given, but is only a potential that must be realized by computation. Without calculation, the image data sets remain completely abstract, nonpictorial, imageless. The conversion of the nongraphic state (which is the norm) into the pictorial state (which is only ever produced temporarily, by the performance of software), is updated contingently and seems fairly expendable from the point of view of the computer (Kittler 1999). Trevor Paglen has summed this up as follows:

> Digital images are fundamentally machine-readable: they can only be seen by humans in special circumstances and for short periods of time. A photograph shot on a phone creates a machine-readable file that does not reflect light in such a way as to be perceptible to a human eye. A secondary application, like a software-based photo viewer paired with a liquid crystal display and backlight may create something that a human can look at, but the image only appears to human eyes temporarily before reverting back to its immaterial machine form when the phone is put away or the display is turned off. However, the image doesn't need to be turned into human-readable form in order for a machine to do something with it. (Paglen 2016)

Without pictorial visualization, however, information (and resources) are also lost, as shown by the still-limited machine-readability of digital images. It becomes clear, for example, from forms of CAPTCHA ("Completely Automated Public Turing test to tell Computers and Humans Apart") that software-constituted image data

objects that appear to the human perception, in a subjectively unproblematic, intuitive way, as images *of something*, can even be repurposed as security queries, due to their relative unreadability for machines. In image theory, the conclusion that has been drawn from this is that

> there is a yawning gap between the endless columns of numbers and the shapes which a human gaze recognizes. . . . On one side there is raw data which codes images as fields of colored pixels; on the other there is a perception which has no choice but to see something: faces, people, spaces, objects. Only gradually are processes of digital vision machines beginning to find image objects within the fog of the number fields.[1] (Ernst, Heidenreich, and Holl 2003, 11, own translation)

And while (to varying degrees) impressive progress has been made by image recognition or image classification processes based on learning algorithms, processes which "train independently" using sample data (such as the data set of the ImageNet project, established as the competitive standard of machine learning), there are still some rather sobering cross-checks, such as the classification of reverse tone images, which are completely unproblematic for human actors (Hosseini and Poovendran 2017).

The continued existence of the "gap" can also be detected in the currently installed "content moderation apparatus" (Gillespie 2018) of social media platforms, where the relative unreadability of digital images is translated into a socio-technical moderation chain, in which human actors on various levels continue to do most of the work: as members of internal policy teams who decree regulation guidelines; as programmers who configure training data accumulated by crowd workers and evaluate the results of algorithmic scanning; as trainers who instruct content moderators on how to analyze images in conformity with guidelines; and as microworking reviewers, who must carry out up to 2,000 assessments of individual images per hour (Rothöhler 2018b). The conclusion that can be drawn from this is that digital images "have information" insofar as they consist of computable data, but at the same time they can also be understood as information that "has" images. The image data of digital images can be computed regardless of their pictorial manifestation, but in many cases, they then lose that aesthetically and epistemically crucial information which, at least from the point of view of human actors, is only present in the visual form, in the pictorial "exterior" of the image data. W.J.T. Mitchell puts this succinctly: "images have always given form to information" (2010, 46).

With regard to the emerging tension between *image file* and *image display*, code and form (Drucker 2014), it becomes abundantly clear that digital images are not fixed objects, but flexibly configurable processes: "no longer a solid representation of a solid world—a 'hardimage' as it were—but an unstable algorithmic configuration of a database: a 'softimage'" (Hoelzl and Marie 2017, 72). This softimage is one that is constitutionally distributed (Rothöhler 2018)—not only in that most digital

images are mainly generated because they can be instantly sent and shared, but also in that these images can no longer be ascribed to a binding media location, a constant materiality, a key actor, a central agency, but can only ever be understood as both fluid and reversible phenomenalizations of an operatively distributed media logistics. Thus, for example, the specific emergence of any given digital image on a platform—of a "social photo," as Nathan Jurgenson (2019) has designated the dominant image type of present-day visual culture—depends on the operative cooperation of numerous actors, including (in generalized terms) data distribution infrastructure such as data centers and transoceanic cable networks, widely used container formats such as Matroska (MKV) and standardized image compression norms such as JPEG, as well as screen hardware and human end users—who still hold a significant proportion of the initiative when it comes to image-related practices.

## Calm Images and the Internet of Things

The defining feature of digital images in general and of circulating digital images in particular, then, is their operatively distributed nature as data images. This also means that digital images consist of discrete, discretely addressable units of information, which can be computed using information technology: "The specificity of digital images lies in their operationality and processability"[2] (Schneider 2009, 191, own translation). If we concentrate, in this respect, on those processes that seem largely uncoupled from the contributions of human actors, we enter a discursive field of image theory that Paul Virilio established, with programmatic intent (and with the semantics of cultural criticism), in the late 1980s. Virilio spoke of "infographic vision machines," which would get by without human eye contact, without "visible context," and would, in future, take over the task of "analys[ing] the ambient environment and automatically interpret[ing] the meaning of events"; he also spoke of "synthetic images created by the machine for the machine" (Virilio 1994, 59–60).

The fact that digital images can have agency, the power to act, even if they are not the object of human perceptions, is captured in Trevor Paglen's paradoxical concept of a rapidly spreading "invisible visual culture":

> Visual culture has changed form. It has become detached from human eyes and has largely become invisible. Human visual culture has become a special case of vision, an exception to the rule. The overwhelming majority of images are now made by machines for other machines, with humans rarely in the loop. The advent of machine-to-machine seeing has been barely noticed at large, and poorly understood by those of us who've begun to notice the tectonic shift invisibly taking

> place before our very eyes. The landscape of invisible images and machine vision is becoming ever more active. . . . Images have begun to intervene in everyday life, their functions changing from representation and mediation, to activations, operations, and enforcement. Invisible images are actively watching us, poking and prodding, guiding our movements, inflicting pain and inducing pleasure. But all of this is hard to see. (Paglen 2016)

And in fact, for some years there has been relatively concrete proof of how—especially in the context of the Internet of things (IoT)—image data circuits are created, which have consequences for human actors but are largely invisible. In the IoT, the use of image technologies is on the increase, most notably when it comes to the addressing of nonnetworked things and environmental observation in general. The invisible visual culture evoked by Paglen is, in this sense, focused on addressing and observing. The idea is that in the IoT, even the most mundane everyday objects will be assigned addresses, and will become intelligently communicating "everyware" (Greenfield 2006) thanks to miniaturized microchips und network access. Here, the promised smartness of the IoT is largely based on things whose intelligence does not lie within themselves, but is an effect of their connectedness through media technology, as the UbiComp pioneer Mark Weiser observed over twenty years ago: "The real power of the concept comes not from any one of these devices; it emerges from the interaction of all of them" (Weiser 1999). The distributed nature of the IoT's things, the inscrutability of the computing power connecting them, which is based on infrastructure such as fiber optic cable systems and data centers, leads to connection services which, on the one hand, allow intelligent cooperation between variously competent media technology actors, but on the other hand are hardly able to be understood or controlled any more. According to Weiser, this leads to problems with the delegation of responsibility: "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" (Weiser, Gold, and Brown 1999).

But why, one might ask, this special significance of image technologies in the IoT? Firstly, simply because systems equipped with image sensors can be used to address objects that are not especially smart, such as nonnetwork-enabled fridge contents. In the case of Samsung's Family Hub RB 7500 there are in fact three high-resolution image sensors, which continuously scan the fridge interior for objects like milk cartons that need to be reordered. In the Internet of things, intelligently networked cameras are special objects (and especially intrusive ones), in that they can detect, locate, and visually store other things (and processes), and connect them with an address, without their active participation. Detection by means of imaging and image data processing can be carried out discreetly, from a distance, and

requires no consent from the objects (or individuals) scrutinized by the gaze of technology. In numerous models of smartness in media technology—one example of a growth market is the application of "ambient assisted living" in elder care—the following is regarded as a fundamental rule of procedure: "vision as a high-level way of capturing information from an environment" (Augusto, Nakashima, and Aghajan 2009). Nonoptical sensor types such as motion sensors do also record things that are not networked, but work with a comparatively low level of data, which limits the options for subsequent processing. In contrast, the neutral-sounding phrase "high-level way of capturing information" indicates that, generally speaking, more patterns can be extracted and modelled algorithmically from image data sets than from data collections originating from other sensory registers. A more recent example of the "depth of information" of imaging processes is the application of Transdermal Optical Imaging, which can use any two-minute smartphone video to detect changes in a person's blood flow pattern, and thus measure systolic blood pressure with 95% accuracy (Luo et al. 2019).

In the invisible image data circuits of the IoT, information acquired from image sensors is automatically analyzed and integrated into more extensive sensor networks, which—for example in smart home concepts such as Alphabet's Nest portfolio—can also capture environmental data according to e.g. mechanical, thermoelectric or magnetic operating principles. The ultimate goal here is always the greatest possible fusion of data. The more sensors are distributed and the more diverse they are, the more information-saturated the environment becomes. Data gathered in nonoptical ways is expected to cooperate with data from image sensors. This also applies to Nest's smart home concept: if Nest detects carbon monoxide, the light is switched on, the Nest Cam is activated, and an alarm is triggered. In this model, the smart home is densely populated with a multitude of "sensing," intercommunicating detectors, which convert different stimuli first into electrical signals, and then into a universally compatible digital data form, so that operative decisions can be calculated and implemented on the basis of data collected in different places but processed centrally. So, what is especially valued about image data within sensor networks is information that it is possible to fuse with information that cannot be materialized in images.

The prerequisite for this "smartification" of environments is a "growing sensorization of environments" (Gabrys 2016). As suggested above, in many cases it is image technologies that are expected to bring the world—objects, environments, events, the behavior of human actors—into the data space. Image data circuits are created here because more and more smart things demand visual input: home security systems, fridges that do the shopping, and self-parking cars are the best-known examples of marketable applications for image-technology-competent "distributed sensing"—visual input for an invisible visual culture, in which image data are gathered and processed, but are no longer given a visible pictorial form as

images. From this perspective, the IoT is being dominated increasingly by image machines that are indifferent to pictorial manifestations. Crucially, what we are dealing with here is uses of image technology whose informative value lies beyond human viewing processes. This is because the computer does not need the visual output to calculate with the image data, following its own rules—which it sometimes does very effectively, at least in clearly delimited contexts of application such as smart front doors and fridges. The Internet of things thus maintains a highly ambivalent relationship with the image: On the one hand operations involving image sensors and image processing are becoming increasingly extensive and important. On the other hand, algorithmic agencies are emerging, which are intended to filter the image data circuits according to instrumental stipulations and to minimize human viewing of images.

For most sensor network images on the IoT, there are in fact no longer any viewers, but only scripts that automatically scan image data sets. Kristin Veel has studied the new status this confers on the image, a status that must be thought of in terms of a circulation process that, fundamentally, operates in the background. Veel uses the example of a security system called Smartgate, working with facial recognition software, which is installed in Australian airports. Following Mark Weiser, Veel speaks of "calm imaging," "focusing in particular on images that are not addressing our conscious, focused attention, but that operate smoothly in the background" (Veel 2012, 120). These images "emerge and are received calmly as a matter of computational exchanges, but in the process they acquire new potentialities, qualities, and risks" (123–124). What is new is not the video monitoring principle of remote surveillance, but the closure of a network-based system in which the distribution and visual materialization of the image information is routinely delegated to subsequent algorithmic image evaluations, or is suspended in favor of these processes. Monitoring with image sensors is automated, and human viewing becomes, as a general tendency, superfluous—or is only called upon if the algorithmic image analysis encounters a pattern defined as an event.

## (In)Visibility and the Regulation of Image Flows

Calm images are images that neither strive for success on social media, nor contribute to the excess of visibility mentioned at the beginning of this paper; instead, they operate discreetly in the background, remain at the ready for automatic selections, and circulate as image data in the invisible visual culture (Rothöhler 2018, 225–274). Yet the fact that these images are not intended to be viewed by human actors, or only secondarily, does not necessarily mean reduced potential for influence, control and decision-making; in fact, these calm images are sometimes more powerful than many excessively shared viral images.

Nonetheless, this new invisible landscape of calm images is not, in every respect, far removed from the excessive visibility usually associated with the platform-based visual culture of the present. There too, calming processes, occurring prior to or in parallel with the circulation of images within visible visual culture, are becoming increasingly influential. For some years, as suggested above, there have been attempts to delegate social media content moderation to technological actants ("automatic detection"), to further reduce the dependence on editorial and user practices of image screening, checking and evaluation. This is mainly a reaction to the constantly growing volume of images in circulation, as Tarleton Gillespie has commented:

> Content is policed at scale, and most complaints are fielded at scale. More important, the ways moderators understand the problems have been formed and shaped by working at this scale. . . . What to do with a questionable photo . . . when you're facing not one violation but hundreds exactly like it, and thousands much like it, but slightly different in a thousand ways. This is not just a difference of size, it is fundamentally a different problem. For large-scale platforms, moderation is industrial, not artisanal. (Gillespie 2018, 77)

The desired improvement in the efficiency of content moderation, which aims to minimize human contributions, primarily for reasons of cost, proceeds via algorithmic systems of image content processing. Thus, recent methods of automated image recognition have attempted, on the basis of artificial neural networks (ANNs), to recognize patterns in bitmaps. These patterns are meant to become operable as image content information: "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" (Gershgorn 2017). Adrian Mackenzie has described in greater detail these automated processes of image recognition—whose operations, while referred to as "image recognition," essentially consist of processes of algorithmic image classification—with reference to the "cat radar detector" 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 and 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. (Mackenzie 2017, 4)

Such limitations point to the structural conservatism of machine learning—whose successes depend on "how well it makes the same distinctions that were made before" (Gillespie 2018, 107). Nonetheless, there is already a well-established trend, not only in the decision-making circuits of the Internet of things but also in the context of social media platforms, to delegate power, operatively binding images to computers. What is already in practice and works relatively efficiently is the filtering (operationalized without any human involvement in the viewing of images) of visual content whose image data has already been identified as belonging to illegal forms of image. The best-known example (and the most widespread one, because of obvious liability risks) is PhotoDNA—an image filtering application developed by Microsoft in 2009, and currently used by nearly all major platform operators. PhotoDNA compares every single user-uploaded image with a database administered by an NGO, the National Center for Missing and Exploited Children (NCMEC), in which the image data of known child pornography content are stored. The currently around 80 million images from the NCMEC database are "forensically" (Farid 2016) identifiable (even when the phenomenalized image form has been modified by user-initiated image manipulation) via a hash function, which compresses the image data set as a hash value, i.e. codes it into a numeric string that is comparatively straightforward to compute.

The problem evoked by Gillespie of the industrial scale of social media content moderation is becoming even more urgent with the proliferation of various live streaming apps, for which a timely intervention regime would need to be operationalized almost as real-time content moderation. For this and other reasons, platform operators increasingly find themselves forced to delegate the observation and evaluation of images—necessary on a large scale—to technological actants of the invisible visual culture. eGlyph, the successor project to Photo DNA (and also supervised by Hany Farid), which focuses on the extremist content of terrorist organizations, is only partially automated. Like most attempts to solve such problems, it is embedded in a "broader sociotechnical apparatus" (Gillespie 2018, 101), which works through scripts that have been co-conceived and observed by human actors and are intended for the identification and evaluation of image content. Nonetheless, it goes a step further than the calculation of image-specific hash functions, which can be regarded as the "fingerprints" of image forensics.

On the one hand, this program hashes and algorithmically scans not just images but more extensive video data (in order to optimize time efficiency by leading content moderators directly to automatically highlighted points in a video data set). On the other hand, it not only seeks to address content that has already been labelled by means of crowd work, but also to assess new image material, for which only certain image content segments are found in corresponding blacklist databases. The aim is to use algorithms to reliably detect the faces of notorious terrorists or just the relevant logos of radical groups, even in newly generated and

previously unmoderated content, to identify them as known patterns, and if necessary to flag them up. Only then do they switch from the exclusively automated processes of the invisible visual culture into a "human-readable form" (Paglen 2016), and are pictorially materialized, as they still need to be subjected to human image checking. Humans are responsible for decision-making, and must make the final judgement about whether this is legitimate news content, a parody, or terror propaganda.

## Image Data as Training Data

While the image-related calming in these cases is focused on channeling and filtering "human-to-human visual culture," there are quite different processes taking place at the same time in the expanding parallel world of invisible visual culture, processes that are not directly aimed at limiting or regulating the volume of image data circulating in pictorial form. Adrian MacKenzie and Anna Munster have shown, for example, that images on social media platforms circulate independent of their pictorial manifestation, and lead operative parallel lives, as it were: on the one hand as images that are distributed on user interfaces, are perceptible for human actors, and in some cases are open to interaction and can take on communicative functions, and on the other hand as "training data," used to operationalize algorithmic learning processes. As such they are inevitably opaque, nongraphic, nonvisual, but in a sense they do contribute—as a feedback loop—to the concrete phenomenality of visual culture (Mackenzie and Munster 2019).

The phenomenon referred to by Mackenzie and Munster as "the invisuality of platform seeing" is based on the observation that images on digital platforms, which are, for example, uploaded to Facebook, Instagram or YouTube by users and are then more or less freely available to the commercial operators as vast repositories of image data, are diverted into an invisible visual culture. Here, the aggregated image data is processed on various levels as sensory input—as technological perceptions serving to train and stabilize processes of algorithmic "platform seeing." This is not just about the use of these continually re-aggregated image repositories to optimize already popular image classification applications such as facial and object recognition, but also about the fundamental significance of image data sets for the operation and evolution of artificial neural networks:

> These forms of AI are driven by deep learning architectures, in which images seem to function merely as a communicative baseload that might power new "visions" for automated and autonomous decision-making and task performance. Ever since Google loaded 10 million YouTube thumbnails of cats into its neural network architecture in 2012, the conception that what an AI needs to learn to

> become more proficient is "more (image) data" has taken hold. . . . a new mode of nonrepresentational observation has become ascendant that we propose is invisual. Here, observation operates in and through the image but is not of the order of the visual. (Mackenzie and Munster 2019, 7)

When the visual information circulating on the platform interfaces as pictorial output is diverted into the invisible visual culture and becomes operable there as aggregated image data, it enters into complex computational circuits, feeding, for example, recognition algorithms such as Facebook's DeepFace or program architectures such as Google's TensorFlow, which is concerned, among other things, with the analysis of street signs in image data from Google Street View (Wojna et al. 2017). In the context of machine learning, these image data are processed not as representations but in a strictly relational way, and they feed back, not least, into algorithmic processes of image optimization:

> The techniques of training such models have intricate and heavily mathematical underpinnings, but nearly everything that happens in the construction of such models can be understood as reversing the flows of image production that have defined visuality in recent decades. Instead of generating images, these models observe images, they construct diagrammatic abstractions of features common in images, and gather these localized abstractions into predictive statements that can be operationalized as actions in the world: "place a black stone at g9 (row 7, column 9)". We might think of the calculative observation of image collections as a generalized visuality since . . . the highly variable data power consumption of a data centre, edge detection for enhancement of digital photographs, or a series of moves in a game of Go or Montezuma's Revenge all operate according to the same logic: a large image collection allows a model to be trained given the computational capacity of GPUs. (Wojna et al. 2017, 17–18)

In this context, feedback loops that retroact on registers of visual culture are most likely to emerge in situations where the learning processes retroact on image generation, that is, where they operate predictively. Hito Steyerl has spoken in this respect of "relational photography":

> By comparing what you and your network already photographed, the algorithm guesses what you might have wanted to photograph now. It creates the present picture based on earlier pictures, on your/its memory. . . . The picture might show something unexpected, because it might have cross-referenced many different databases: traffic control, medical databases, frenemy photo galleries on Facebook, credit card data, maps, and whatever else it wants. [Computational photography] is not only relational but also truly social, with countless systems and people potentially interfering with pictures before they even emerge as visible. (Steyerl 2017, 29–30)

What future images are possible, or more precisely, statistically probable, what pictorial "exteriors" actually emerge from the trillions of images making up the visual capture in the everyday digital life of the present, is based, from this perspective, to a considerable extent on feedback loops, which connect visible with invisible visual culture, pictorial interfaces with calm background activities. Insofar as algorithmic processes of scanning, recognition and filtering govern digital image distribution, and image-predicting processes feed into image-generating processes, calmly circulating image data and virally circulating image forms are not so much opposites as two cooperative sides of the same digital media culture.

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## Notes

1 "[dass] zwischen den endlosen Ziffernkolonnen und den Gestalten, die ein menschlicher Blick erkennt, . . . eine Lücke [gähnt]. . . . Auf der einen Seite stehen Rohdaten, die Bilder als Felder farbiger Pixel kodieren; auf der anderen Seite eine Wahrnehmung, die nicht anders kann, als etwas zu sehen: Gesichter, Personen, Räume, Gegenstände. Nur langsam beginnen Prozesse digitaler Sehmaschinen, Bildobjekte im Nebel der Zahlenfelder zu finden."

2 "Das Spezifische an digitalen Bildern liegt in ihrer Operationalität und Prozessierbarkeit."

# 5. Unmoving Bodies: In-Flight Entertainment, Infrastructural Images and Cultural Techniques of Sitting

*Dominik Maeder*

**"Never just sit"**

When researching this article on my private PC during the global Coronavirus pandemic in 2020, I looked up various internet sources on the history of seats and chairs in general and airplane seats in particular. Inevitably, the search queries crept into my Facebook ads, which started to offer a plethora of chairs, stools and armchairs to me. Among them, one ad stood out with the slogan "Never just sit" (aeris.de 2020). It seemed rather unexpected for a company ultimately wanting to sell furniture to sit on. Indeed, the company's marketing strategy aims at selling (among other products) flexible office chairs and stools with a semantics of movement: "We are against motionless sitting, which makes you tired and sick" (aeris.de 2020), their mission statement reads. Citing health claims and evoking the powerful discursive registers of activity and mindfulness, 'sitting' is located here on the threshold between governmental concern about public health as well as worker productivity and body-centered techniques of the self. Moreover, it demonstrates how pervasive semantics of perpetual movement have become when even seating furniture cannot sell without being rebranded as a tool for movement.

In the wake of the mobilities turn and with regard to the increasing importance of mobile media, cultural and media theory does not escape this emphasis of movement, motility and mobility. In concerning myself with aerial mobility in this article, however, I aim to highlight the crucial role images play in *immobilizing* bodies for passenger flight operation. In-flight entertainment, I argue, is a media technology which, by making moving images accessible, aims at *unmoving* the passengers. While travelling across the globe, the images of in-flight entertainment therefore cannot properly be grasped as mere objects of transportation: rather, they are part of the operational logic of aerial passenger transport itself and thus take on the quality of infrastructural images. They contribute to a successful performance of aerial infrastructures precisely by occupying passengers *without moving them*.

In this chapter, I argue that within the potentially claustrophobic space of ultra-dense aircraft cabins, in-flight entertainment opens up a trajectory of escape by providing a vast media space that differs from the fact of flight. This media space, however, is closely guarded and managed by airlines so as not to disturb, frighten or incite viewers. It is therefore a space of inhibited, suspended and deferred affect, a class of affects which I call 'sessile affects.' This necessitates further elaboration on the interrelation between (suspension of) movement, images and affect from the perspective of affect theory and film theory. While these perspectives are necessary to kick off an understanding of how movement and feeling can be tied together within images, my approach will not focus exclusively on affect or film theory. Focusing on motionlessness rather than motion, I will outline how sitting can be conceived of as a cultural technique of the body, which is essential for understanding the inverted relationship between the cultural technique of sitting-down and the cinematic presentation of in-flight entertainment, where images serve the purpose of spectators staying seated and not the other way around. To further sharpen a comprehension of the crucial role of seats and the cultural practice of sitting-down irretrievably connected to them in aviation, I will then delineate how airplane cabins have become ever denser arrangements of seats in the jet age, due to safety as well as economic reasons. Seats from this perspective are efficient storage media for living human bodies, giving plausibility to the tongue-in-cheek description of passengers as 'self-loading freight' in aviation lingo. The emerging aerial regime of sitting is not only historically tied to the rise of in-flight movies and in-flight entertainment systems. Images in air moreover contribute significantly to the logistics of passenger transport itself by unmoving bodies. In-flight entertainment and its sessile affects, I conclude, therefore reveal the infrastructural power of images.

## Making Space: Unmoving Images

Experimental attempts at 'airing' movies in-flight can be traced back to the 1920s, yet in-flight entertainment as an industry-wide practice really 'took off' with the advent of post-war jet travel and its densified interiors (cf. Groening 2014, 65–79). Boeing's 747, for instance, was designed from the outset with in-flight entertainment systems in mind (Groening 2014, 83–84). While early installments quite literally transformed the airplane and its darkened cabin with forward-facing seats into a movie theater by placing a screen in the front, a projector beneath the cabin ceiling and playing sound throughout the cabin,[1] airlines subsequently made in-flight movies increasingly accessible and opt-in, for instance through the introduction of multiple TV monitors hanging from the ceiling and the use of headphones (cf. Groening 2016). As full-featured entertainment systems installed into

the back (or armrest) of every seat and operated by per-seat remote or touch control, since the 1990s digital on-demand IFE has become more and more individually customizable and networked (cf. Groening 2014, 115–128), thereby pioneering the operational logic of digital media and turning spectators (of non-theatrical cinematic exhibitions) into users (of digital entertainment systems). While they may include premium services such as satellite-internet, live TV or in-flight telephony, access to most features of IFE systems (typically movies, tv shows, airline-specific promotional films, e-journals, audiobooks, podcasts, music, and games as well as flight information such as moving maps and, if available, exterior camera views of the airplane) usually comes free of charge to passengers. For airlines, however, IFE is a serious cost factor with IFE systems easily costing up to $10,000 per seat plus content license fees, and adding weight as well as maintenance complexity, e.g. in the form of excess wiring, to the airplane and its operation. Contemporary IFE solutions, produced by a variety of specialized third-party manufacturers, therefore scale back on hardwired back-seat monitors and rely increasingly on mobile wireless devices handed out to passengers or making use of private devices already brought on board by passengers (cf. White 2018).

While IFE is neither a distinguishing feature for airlines—passengers don't book a flight to see movies—nor a revenue source, it is nonetheless expected by passengers for long-distance air travel, "a service every airline must have in order to stay competitive" (Groening 2014, 83). The common denominator with which IFE manufacturers and airlines alike describe in-flight entertainment is the umbrella term 'experience,' often specified as 'spectacular,' 'immersive,' 'exceptional,' 'satisfying,' and so on. The concept is also present in the naming scheme of the corresponding trade association Airline Passenger Experience Association (APEX). What's noteworthy about these loose semantics is that—contrary to the earlier days of air travel (cf. Van Riper 2004, 83–107)—the experience does not lie in flight itself but within a media space. IFE is not an experience *of flight*, but an experience *in flight* that differs from experiencing flight itself.

This is due to safety concerns on the one hand, as flight itself can be perceived as inherently dangerous, and to the economics of the aircraft cabin on the other. For the experience of flight is foremost a visual experience that is tied to the 'aerial view' involving both estrangement from and sublime ascension above the landscape (cf. Dorrian 2007). This view, however, is tied to the presence of a window to look out of. In ultra-dense aircraft cabins of widebody jets, window seats are rare, and on transatlantic or transpacific flights they offer comparably dull views of the oceans for extended periods of time anyway. Thus, the paradigmatic view for commercial aviation does not follow a centrifugal trajectory towards the outside. Instead it follows a centripetal trajectory and is directed into the interior space of the cabin itself.[2] And while airlines try to make airplane interiors seem spacious and pleasant-looking—including coloring, lighting design (cf. Maeder 2018)

and the appearance of flight attendants (cf. Vantoch 2013)—the lack of space that comes with ever more efficient seat layouts makes the aircraft cabin a potentially claustrophobic environment, a "panic room sui generis" (Rothöhler 2009, 44). Passenger management thus includes drawing attention away from both the (potentially hazardous) fact of flight and the claustrophobic interior of the aircraft cabin. By opening up media spaces within the cabin, in-flight entertainment therefore also serves as a counteragent to the fear of flying:

> In a sense, the stimuli on these screens are attempts to transport the viewer outside the situation of flight. The distraction of the audiovisual on the screen gives the passengers the opportunity to imagine themselves somewhere else—anywhere other than thousands of feet above the earth in a metal tube. (Groening 2014, 139)

At the same time, however, the media spaces opened up by IFE are carefully managed as well, for they are intended to captivate but not move the audience from their seats, transport them 'anywhere' as long as they stay seated. This management of passenger captivation performed by airline IFE managers typically involves content selection—films about aviation disasters or plane hijackings, for instance, will usually not make it (in)to (the) 'air'—as well as editing and production. Movies have to be edited for technical reasons, to fit the screen ratio of IFE systems (typically 4:3 or 16:9) as well as for their contents. Film production companies even compile airline coverage notes informing airlines of potentially unwanted content such as nudity, excessive violence or controversial depictions of religion, race or culture, sometimes even producing alternate scenes to accommodate airlines' needs or simply editing or substituting undesired visual or audio contents in post-production (cf. Chariton 2005). While the standards of individual airlines may differ according to the cultural norms of their respective markets, they are always "aimed towards pacification and placation. Content that might provoke anxiety, violence, offence or indeed any strong feeling is discouraged" (Groening 2014, 141).

In this regard, airlines treat movies like television traditionally would, employing a 'family-friendly' strategy of 'least objectionable programming' (LOP), which eliminates any potential controversy by avoiding sensitive issues altogether. Especially the romantic comedy with its emphasis on personal communication, close-ups, accessible plots, and avoidance of outright depictions of sexuality in favor of courtship has accordingly been identified as the ideal movie genre for presentation on small screens in mid-air:

> if the romantic comedy itself relies on transforming that which cannot be named (sex) into a joke, it is a genre well versed in the art of diversion. Inflight entertainment thus puts romantic comedies into service of a double denial of sex and crashing. (Groening 2014, 141)

We may also read this 'double denial' as a sort of affective inhibition that circumvents the kinds of affective engagements that would truly move us out of fear, joy, arousal or excitement by obstructing them in the way seatbelts obstruct our motility.

That is, however, not to say that in-flight movies completely lack the potential to touch us. The kind of intimate sentimentality that the romantic comedy, as *the* genre of inflight-movies, produces is not aimed at proliferating affective intensities, which make us scream, flinch, jump, laugh out loud or burst into tears. Instead, here affect is incited only as much as it is deferred, suspended and inhibited at the same time. These feelings are not centrifugal affects that would move us and make us move, but rather centripetal affects, which touch us only so far as not to make us move, creating an "artificial interiority and inwardness" (Kappelhoff 2004, 29) rooted in a bourgeois culture of sentimental sensitivity, which cinema has been part of since the advent of narrative cinema (cf. Kappelhoff 2004, 16–20). While this culture of inward sentimentality is closely linked to film melodrama and its "mode of excess" (Brooks, quoted in: Kappelhoff 2004, 19), in-flight entertainment cuts off this excess in different ways: First, the screen size doesn't easily allow for the kind of narrative immersion necessary to give in to the filmic sensation completely. Consequently, other passengers' screens remain present in our peripheral vision, sometimes leading to parallel movie viewing. Secondly, airplane cabins never achieve, and this is deliberate, the same darkness as movie theaters because unlike cinema, they are spaces of asynchronous, individualized schedules. Thirdly, movie presentations may be constantly interrupted by in-flight services, other passengers, flight-related announcements or turbulence. The airplane does not serve the movies like the movie theatre would, the movies are subordinated to the airplane, they serve the operation of flight.

In this sense, sentimental sensitivity on the airplane is purposefully anti-excessive; while invoked, it is restrained, interrupted, fragmented. If we think about the suspension of movement as movement, about sitting-still as a way to move around, we can think of restraint, interruption and fragmentation, deferral, suspension and inhibition not as a negation of affect, but rather as a difference of affects. More precisely: sessile affects that unmove bodies.

## Affect, (Suspension of) Movement and Cinema

Brian Massumi's seminal book on the theory of affect commences with a paragraph on the interrelation between movement and feeling that, although widely quoted across the fields of studies on affect and (moving) images, will be reproduced once again here:

> When I think of my body and ask what it does to earn that name, two things stand out. It *moves*. It *feels*. In fact, it does both at the same time. It moves as it feels, and it feels itself moving. Can we think a body without this: an intrinsic connection between movement and sensation whereby each immediately summons the other? (Massumi 2002, 1)

While I neither intend to challenge Massumi's assumption nor to delve into the intricacies and eccentricities of affect theory in general, I want to use Massumi's rhetorical question as a starting point for thinking about the relation between movement, affect and images by taking it seriously: Can we think a body without movement? And would that lack of movement necessitate a lack of feeling? It *doesn't move,* it *doesn't feel?*

In asking these questions, however, I do not want to suggest thinking of lack of movement as the opposite of movement: A living human body standing, sitting or lying certainly still maintains a relation to its capacity to move, its motility, to movement as a potentiality, while refraining, being unable or prohibited to actually move. And this lack of movement would certainly be felt as such by the body: *it feels itself not moving*. While my thinking about (lack of movement) therefore should not be regarded as a true challenge to affect theory, I cannot help but notice that Massumi's deeply affirmative stance towards movement and his emphasis on actual movement causes some of his disciples to one-sidedly privilege phenomena of actual movement, such as dance or gesture. Contributing to this privilege of movement over non-movement is that key figures of cultural theory such as Benjamin's flâneur or Deleuze's and Guattari's nomad conceptualize modern subjectivity as thoroughly motile (cf. Adey 2017, 81–92). This, in turn, means that phenomena relating to movement only in the manner of potentiality, i.e. as lack of actual movement such as sitting, standing-still or lying-down, have been underappreciated by cultural theory, mobility studies and affect theory, which sometimes seem to confuse actual movement with the potential capacity to move. The polysemic nature of the term 'movement,' which can be used to denote both motility and feeling, seems to contribute to such an understanding of corporeal movement through physical space (*to move*) as corresponding to an interior movement of feeling and sensation (*being moved*). Likewise, 'emotion' has an etymological root in 'motion.' 'Affect' then precisely denotes the "join" (Kavka 2008, 34) between these two kinds of movements, between motion and emotion, body and mind, which are not thought of as belonging to different realms. Rather, both the moving body and the body moved by feeling are thought of as inhabiting the very same physical realm.[3] While I would caution against giving in to the lure of language to quickly, there is no reason not to think of standing-still, sitting or lying as phenomena of movement from within the framework of affect theory itself.

First, there is residual (and mostly invisible) bodily movement in all situations involving lack of movement: the heart beating, the lungs expanding and contracting, and so on. On this level, there truly is no body completely without movement. This, however, is true for the dead body, too. At least for some time body fluids will continue to move through the body and its decay involves movement on a cellular level even for a longer period of time. Moreover, it's true for the entirety of physical entities in the known universe: atoms combining and decaying, quarks spinning, planets orbiting, the universe expanding. There's simply nothing without movement in some form. "All existence moves" (Sheller 2018, 137). Or, it *moves*, it *exists*. This might, whichever way you want to spin it, either support affect theory readings on the level of ontology or point to the need to establish a more precise terminology when speaking about different kinds of movement.

Secondly, lack of movement is only partial. We may for instance sit down to write a text and keep most parts of our body immobile for the better part of the process, yet our hands and fingers will move a lot to operate the keyboard and mouse, grab a book from the desk, etc. Likewise, our eyes will constantly move to scan the words written on the monitor, while occasionally our head will move as well, be it only to distract ourselves or because keeping it still is actually exhausting (and unhealthy) for our body. For the same reason we will arch our back from time to time, move our feet, etc. Even when lying down to sleep our body will perform these types of movements as well as be in motion in other involuntary ways, e.g. muscle twitching. Following Deleuze, we may think of this interplay between motion and motionlessness as characteristic for affect itself. With regard to the face, the prime example for his deliberations on the affect-image, Deleuze highlights the "relative motionlessness" (1997, 97) of the face as a precondition to it being able to provide an image and surface upon which the micro-movements of facial expressions become intelligible. The ability to be moved by affect comes "at the cost of motionlessness" (1997, 96)[4]. Moreover, partial motionlessness of the body, particularly in the form of sitting still, is a precondition to operating vehicles that provide a form of machinic mobility, notably biking, car-driving or flying.

Thirdly, situations involving (partial) lack of movement can be and often are situations of high or even heightened affective involvement, e.g. sitting down for a job interview, standing before the altar (or registrar), dreaming while lying down. This is particularly true for situations involving entertainment media: reading a novel, for instance, typically suspends bodily motion for the most part, yet can entail high affective involvement. Even more pertinent is the case of (narrative) cinema, where heavily restrained movement or complete lack thereof is a necessity for the collective reception of a movie. Here, the inability to move is even considered to heighten the experience of moviegoers, for it not only directs attention away from the body and towards the screen: the moving nature of cinematic images is thought of moreover as compensating for the corporeal motionlessness. In the cinema, we

trade—so to speak—one kind of motion (of our own body) for a different kind of motion (the motion of images). "And if the eye which moves," Jean-Louis Baudry writes with regard to the camera, "is no longer fettered by a body . . . the world will be constituted not only by this eye but for it" (1986a, 292). For Baudry, this trade-off between lack of bodily movement and movement of the images actually constitutes a favorable barter for the spectator. According to Baudry, camera movement unconstrained "by the laws of matter and time" (1986a, 292) allows for the phantasmatic presentation of an intentional object on screen and a corresponding transcendental subject, the camera and the spectator identifying with it, at the same time. Despite obviously following a different line of argument with wide-ranging implications, his reasoning may well be aligned in parts with affect theory. We may think of Baudry's transcendental subject, even against his liking, not so much as a subject of cognizance but rather of heightened affective involvement with the screen, for the screen does not merely represent an external object, but by virtue of the camera also connects subject and object as a "join" (Kavka 2008, 37). Summarizing yet another theory of film, Eisenstein's theory of montage, Hermann Kappelhoff puts it like this: "In the perceived figure of movement the spectator records a figure of expression, which he transforms into an emotion, a figure of sensation that he literally realizes on his own body"[5] (Kappelhoff 2008, 313). Or, again in Baudry's terms: "to seize movement is to become movement, to follow a trajectory is to become trajectory" (Baudry 1986a, 291–292).

## Suspension of Movement as a Cultural Technique of the Body

Lack of movement and affective involvement, therefore, should not be thought of as mutually exclusive. Even from within a theory of affect, and especially with regard to film theory, (partial) motionlessness and affect are closely linked. In one way or another absence of motion even seems to be a prerequisite to affect flowing. It *doesn't move*, yet it *feels*. This opens up a wholly different perspective on affect, one that escapes the sometimes lofty and imprecise coupling of movement and affect. It urges us to consider the cultural techniques of non-movement, such as sitting, standing still and lying down as fundamentally corporeal techniques to attune oneself to situations of heightened affective involvement. As Marcel Mauss has argued, these "techniques of the body" (1973, 70) make the body appear as a hybrid "natural technical object" (75), which, in exerting its innate capabilities, makes use of the body as a technical means that can be operated in manifold, culturally contingent ways. Most notably, Mauss' catalogue of corporeal activity includes those techniques involving "suspensions of movement" (80), such as sleep and resting. The latter category encompasses "lying down, sitting, squatting" (81). Both sleep and resting, however, point to another dimension of cultural techniques, and in-

dicate that they often involve or even rely upon objects. For instance, Mauss makes his most basic distinction between "those societies that have nothing to sleep on except the 'floor,' and those that have instrumental assistance" (80) and continues to differentiate "people with benches and people without benches and daises; people with chairs and people without chairs" (81). Evidently, these objects are not thought of as merely neutral instruments for exerting techniques of the body, they are fundamental elements of the "operational chains" (Schüttpelz 2010, 111)[6] of cultural techniques. As such they always already include, teach, and, to a certain extent, predetermine how the body can be deployed: a yoga ball will make you sit differently to an armchair, just as a hammock will require you to lie down differently to a flat bed, for instance. These everyday objects are nothing less than archives and transmitters of cultural techniques of the body.[7]

The cinematic apparatus, as Baudry described it, relies so heavily on the audience performing the bodily technique of sitting-still that Baudry himself never convincingly considers how the audience actively immobilizes itself. According to him, instead they "find themselves chained, captured, or captivated" (Baudry 1986a, 294) and come to enjoy this "forced immobility" (Baudry 1986b, 303) as a re-discovery of the pre-mirror-stage experience of the child (cf. Baudry 1986b, 303). The force that acts upon the spectators, makes them lean back into their chairs, rather than being of metapsychological nature, may however be more precisely located in the seat itself: "A chair is only finished when someone sits in it" (Hans J. Wegner, quoted in Rybczynski 2017, 1). Seats make you sit because they are essential objects within the operational chains constituting the cultural technique of suspending bodily movement in the form of sitting-still. When there's a seat, we're accustomed to taking it. By no means is sitting-still therefore a mere function of the cinematic apparatus as Baudry suggests; instead, it is a cultural technique upon which a certain type of cinema can draw in order to develop its distinct mode of representation. Indeed, we learn to sit still from a very young age, for instance in school, in bourgeois dining etiquette, or in bourgeois entertainment forms such as theater. Even in cinema, arguably, sitting-still became part of cinema etiquette only through the advent of narrative cinema. While seats were an essential part of early cinema as well, audience conduct may have been more akin to the visceral experience of variety shows, which involved increased audience activity on a sensory as well as a physical level (cf. Gunning 1986, 66–67; Hansen 1991, 23–59).

The cultural technique of sitting-still therefore serves the cinematic apparatus: it produces the "forced immobility of the cine-subject" (Baudry 1986b, 313) upon which the cinema relies in order to deploy its mode of representation. This, at least, seems true for a classical era of cinema that is tied to the physical location of the movie theater. With the increasing dissemination of cinematic exhibition into non-theatrical venues such as television and (on-demand) video, the cinematic ties to the movie theater are loosening. Cinema, in Casetti's terms, is relocated by trans-

porting its content into other media and into different environments (cf. Casetti 2015, 47–52). Accordingly, the hierarchical relation between the cultural technique of sitting and the cinematic, i.e. sitting down *to* watch a movie, come into question. Parents, for instance, have long known that you can use television, tablets and other media to make (children's) body sit (rather) still. It cannot be taken for granted, therefore, that sitting down only serves the cinematic experience. The cinematic experience might in turn serve the purpose of making bodies suspend their movement as well. This is the case when another vector of movement is added into the equation of (un)moving bodies, moving images and moved minds, i.e. when the entire exhibition site is on the move. This is apparent in backseat entertainment found in (luxury) family cars and on airplanes, but can be applied to all sorts of mobile media-based in-vehicle entertainment, e.g. private tablets, smartphones or laptops used on trains, subways, long-distance bus services, etc.[8] These forms of moving images provided as in-vehicle entertainment are subordinated to the mobility of the vehicle: we do not enter cars or board planes to watch a movie. Rather, in-vehicle entertainment makes us sit still for extended periods of time and within the confined space of a single seat. The moving images do not move us, they are intended to suspend movement.

This becomes most apparent in in-flight entertainment (IFE) because the aircraft cabin is probably the physically densest as well as best safeguarded intravehicular space in passenger transportation. In the case of wide-body long-haul and ultralong-haul aircraft it is also shared by a large number of people for extended periods of time. Air travel has pioneered in-vehicle entertainment since the 1960s and therefore can be used as a prime example to showcase the inverted relation between moving images and their power to (un)move the spectator: In his landmark work on in-flight entertainment, Stephen Groening emphasizes this inverted relation between immobile spectatorship and the screen very well:

> Built into the structure of cinematic spectatorship is the presumption of immobility and captivation: inflight entertainment, however, is an instance of cinema in which the immobility of the spectator precedes the introduction of the film. That is, rather than carving out a special place for the spectator to remain immobile in front of the screen, the film industry had to construct a special place for the screen in front of already immobile spectators. (Groening 2014, 14)

Due to the extreme spatial constraints of the airplane cabin, the screen space has been 'carved out' of the seat itself, with back-seat monitors becoming the de facto standard of IFE since the 1990s and evolving into a defining feature of the visual atmosphere of an aircraft cabin ever since (cf. Fig. 5.1). Airplane seats therefore make the passenger sit in a dual sense: as they are the only piece of furniture available to the passenger's body, they necessitate him or her to sit down. And they

(are intended to) make him or her endure staying seated by putting images in his immediate field of view, which is the seat in front.

Figure 5.1: Array of screens 'carved out' of the seat-backs on an Emirates Boeing 777.

## Aviation and the Cultural Regime of Sitting

Seats and the regime of sitting-down which they represent are so ubiquitous on today's airplanes that we barely think about them. While seats are not technically necessary for the operation of an airplane—the Wright Flyer, for instance, had the pilot lying on his stomach in order to reduce drag—piloting is an overwhelmingly sitting task due to the spatial confinements of the cockpit on the one hand, and the ability of the sitting body to use both feet and arms to operate the control interfaces of an airplane (most basically rudder pedals for yaw movement, yokes/sidesticks for roll and pitch, and throttle for thrust as well as toe brakes for deceleration on the ground) on the other. Moreover, the experience of flying aboard an airliner as a passenger is an experience firmly tied to the cultural regime of sitting-down even to the point of serious physical discomfort. Numerous reasons can be identified for this connection between air travel and the regime of sitting.

First, there is safety: a sitting body can be strapped to its seat with the help of seatbelts, preventing it from being flung around the cabin in the case of a hard landing or turbulence mid-air. Contemporary airplane seats have to withstand longitudinal forward forces of 16 g (cf. Anderson 2011, 6) and many airlines advise their passengers to keep their seatbelts on at all times, if only to avoid litigation. In addition, large-scale movement of passengers within the cabin might potentially interfere with load balance and have adverse effects on aerodynamic performance. Post-9/11, moreover, passengers standing up have been perceived increasingly as a potential security threat. Numerous filmic depictions of plane hijackings after as

well as before 9/11[9] have contributed to this fear of the rising passenger, especially if they are non-white. On flights into the United States, for instance, airlines are required to notify passengers not to congregate in groups in front of the lavatories. While standing up and walking around is recommended from a health perspective, safety announcements such as these do enable a safety regime of (calmly) sitting down, and a legitimate reason to deviate from this is required (such as a bathroom break).

Secondly, and more importantly, seats are tied to the economy of flight: with the advent of mass air travel by jet starting in the late 1950s, continuing throughout the 1960s and epitomized by the introduction of Boeing's 747 'Jumbo Jet' with its (theoretical) capacity of up to 550 passenger seats in 1969, airlines adopted an economy of scale that made transportation by flight vastly more achievable for the middle-classes, yet required airlines to densify the airplane cabin in unprecedented ways in order to accommodate large numbers of low-fare passengers (cf. Vantoch 2013, 96–110; Van Vleck 2013, 239–280). Deregulation in the airline industry from the 1970s onwards and the subsequent rise of dedicated low-cost 'no-frills' airlines such as Southwest, JetBlue, Ryanair, and Easyjet only accelerated this trend alongside rising fuel costs. Since the dawn of the 'Jet Age,' economy class seats are typically between 17 and 18 inches wide, while seat pitches nowadays may be as low as 28 inches. Cabin configurations, which vary between aircraft types, airlines and sometimes even within an airline's fleet, may include up to ten seats per row in wide-body, long-haul aircraft (cf. Fig. 5.2).

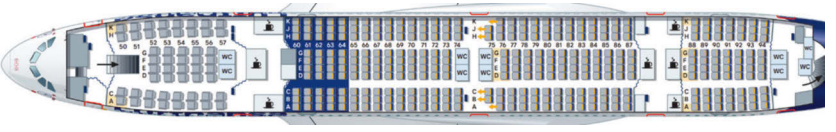

Figure 5.2: Diagram of a cabin configuration for the Lufthansa A380 lower deck with premium economy rows 50-57 in 2-4-2 layout and economy class rows 60-94 in 3-4-3 layout.

While staying seated has thus become increasingly uncomfortable, often getting up is not an easy option, as the lack of legroom necessitates other passengers standing up as well to let others 'out' of their row, while the aisle itself is often a narrow thoroughfare heavily trafficked by packed trolleys and busy flight attendants running on tight schedules to complete in-flight services (food, drinks, garbage collection, on-board shopping, etc.) on time.

Unsurprisingly, the availability of space itself and the opportunity to escape the regime of sitting is the prime differentiator between airfares. Business-class seats on most long-distance airliners these days feature the ability to fully recline to the

horizontal 'plane,' allowing for the body to lie down and (more easily) sleep. When retrofitting their long-haul fleet with 'fully flat' business seats in 2012, Lufthansa dedicated an entire TV commercial to this feature. Drawing upon the then-popular 'planking'-meme, the ad depicts people randomly lying down in public places (Figs. 5.3–4), visually most incisively on a glass roof with an airplane flying in the sky overhead (Fig. 5.5). "Because people like to lie down," the accompanying text reads succinctly before the commercial finally, but rather briefly showcases the reclining airplane seat, operated by a white middle-aged man (Fig. 5.6).

What is advertised here as a premium is the ability to fulfill a very basic need for physical comfort, more precisely: the opportunity to escape the regime of sitting without disturbing the operational constraints of the airplane cabin. Likewise, the introduction of premium economy classes within the airline industry following reduced demand for business-class travel in the wake of the financial crisis 2008, as an intermediary airfare between economy and business-class, uses space as a differentiator, mostly selling seats with slightly more legroom and seat width as well as marginally better in-flight service for significantly higher prices.


Figure 5.3-5.6: Lufthansa commercial for fully flat business-class seats (2012).

Evidently, airlines have a profound interest in minimizing passenger discomfort even for those passengers who cannot afford to pay premium fares, while at the same time having them stay seated. Here, in-flight entertainment comes into play as a technology that contributes to the cultural regime of sitting, not by expanding physical space but by opening up a different, mediated space of entertainment within the tightly confined space of the airplane seat: "the passenger is integrated into the spatial logic of flight management organized around the locus of the seat itself: part of the new ergonomics of the captive audience" (Govil 2004, 243).

## Infrastructural Images

The sessile affects deployed and incited through in-flight entertainment are of crucial importance to flight operation, as they enable the long-distance transportation of large numbers of passengers by making them conform to the cultural regime of sitting, which air travel enforces. The true force of these images in motion can thus only be estimated when taking into account their power to suspend and inhibit movement. The power of these images is not due to their mobility, as they do not become mobile as proper objects of transportation in the first place. Unlike the postcards sent by air mail[10] or artworks and other pictures transported in the cargo holds of aircraft, it is not their purpose to travel. While they are *relocated* cinematic images (cf. Casetti 2015), they are *not* being *transported* from one place to another, instead they form *part of the logistics of transport itself* by perpetually staying in motion and suspending the movements of spectators/passengers. And while they may help travelers prepare for their journey—for instance in the form of travel documentaries naturally being an important type of in-flight movie selection—they, i.e. the digital files stored on hard drives from which actual images are generated, ultimately move back to the airport of departure aboard the very same aircraft with which they have arrived.

These unmoving images, therefore, can best be described as infrastructural images, which form a vital part of the operational logic of aviation infrastructure, as by being in motion they help unmove the body in its seat, prevent it from becoming unruly and thus enable the ensemble of men, things and machines that is the airplane to become mobile in an economically profitable as well as safe manner. Aviation infrastructure thus relies on media infrastructure, in this case: on images that contribute to aviation's infrastructure success by enabling passengers to adapt their bodies to a situation of severe spatial limitation. Media and infrastructures have been linked together increasingly in contemporary media theory, highlighting e.g. material media networks of cables, antennas or satellites (cf. Parks 2005; Starolsielski 2015; Parks and Starosielski 2015) or conceptualizing infrastructures as media and vice versa (cf. Schabacher 2013; Näser-Lather and Neubert 2015). Far from being merely 'immaterial,' 'virtual' or ephemeral to the materiality of media infrastructures, the infrastructural images of in-flight entertainment are endowed with a material force acting on human bodies. This enables them to play a vital role in transforming the airplane cabin into a moving storage medium for passengers. This draws attention to the similarity between transport vehicles and storage sites such as warehouses, which also temporarily suspend movement (of goods) as part of logistical operations (cf. Hockenberry 2020).

There are, of course, more types of infrastructural images involved in flight operation. The so-called 'glass cockpits' of current-generation airliners are essentially multi-screen environments for the conduct of flight, while radar-based surveillance

images are necessary to manage the traffic flow in the sky (cf. Budd 2009, 124–126) just as multi-screen control rooms are crucial for baggage routing inside the airport (cf. Potthast 2007, 110–130) or for the management of an airline's fleet in a flight operation center, just to name a few instances of infrastructural images in aviation. While most of these images require people to sit in front of them and perform the work of monitoring, it is not their primary purpose to make them stay seated. As "working images," to use Pantenburg's (2017) variation of Harun Farocki's term 'operational images,' they are part of work operations or even perform work themselves (cf. Pantenburg 2017). An image of a baggage belt being stuck, for instance, will tend to make the spectator/worker get up and see for him/herself what's wrong with it. In the same way, displays alert pilots to perform tasks related to the conduct of flight. While these very rarely involve getting up, they do almost always necessitate physical activity, ranging from pushing buttons, turning knobs and typing on keyboards to manipulating flight controls and the throttle lever. These images, although of an infrastructural nature as well, are usually data-rich and diagrammatic, and may be cognitively challenging, thus requiring (extensive) training. They require the suspension of movement only in so far as enabling specific moves when they matter.

The images of in-flight entertainment, however, only make us move when they switch off at the end of a flight. It is their absence that signals to our bodies to get up, that undoes their power to unmove us. Only then do we have to be verbally reminded to 'remain seated with your seatbelts fastened until we have reached our parking position.' A parked plane is the precondition for 'unparking' passengers.[11] And only then, with the airplane coming to a stop, are bodies allowed to move again, trading vehicular mobility for personal motility.

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## Notes

1 To draw upon Casetti's distinction between cinematic relocation as "delivery" or "setting" (2015, 50–53), in airplanes, cinema found a venue, an environment that had been of cinematic quality due to its setting (forward-facing seats, darkened, enclosed) even before cinematic contents relocated to it.

2 For the distinction between centrifugal and centripetal aerial views, cf. Rothöhler 2009, 44–49.

3 In following a nuanced understanding of affect put forward by Kavka, my intent is to soften Massumi's strict distinction between affect and emotion by characterizing affect as a "zone of potential emotions" (2008, 31). For the physical transmission of affect, see also Brennan (2004).

4 All quotes translated from German are by the author: "das Gesicht in seiner relativen Unbeweglichkeit" (97); "um den Preis ihrer Unbeweglichkeit" (96).

5 "Der Zuschauer erfasst in der wahrgenommenen Bewegungsfigur eine Ausdrucksfigur, die er in eine Emotion, eine Empfindungsbewegung transformiert, die er buchstäblich am eigenen Leib realisiert."

6 Schüttpelz takes the term "operational chain" [German: "Operationskette"] from Leroi-Gourhan, but tailors it to his approach to a theory of techniques of the body and cultural techniques. For an overview on cultural techniques in German media theory, see also Geoghegan (2013).

7 For a cultural history of sitting as a technique of the body, cf. the catalog for the exhibition *sitzen: Eine Betrachtung der bestuhlten Gesellschaft* (Eickhoff 1997). For a design history of seating furniture with a focus on materiality, cf. Rybczynski 2017.

8 Watching a movie on a train with a portable DVD player also serves as initial example for Casetti's reflection upon the "relocation" (Casetti 2015, 47) of cinematic content.

9 Most prominently *Passenger 57* (United States 1992) and *Air Force One* (United States 1997), most recently *7500* (Austria/Germany/United States 2019) and the Netflix series *Into the Night* (Belgium 2020).

10 For a history of commercial aviation that emphasizes its ties to the postal service in general, see van der Linden 2002.

11 For an ethnographic approach to air travel that emphasizes the changing assemblages of things and bodies, cf. Schindler 2015. For the notion of 'parked' passengers, see page 302.

# Formats and Mobility of Images

# 6. Cartes-de-Visite, Miniaturization and the Materiality of Circulation

*Nicole Wiedenmann*

Even though the history of the carte-de-visite has been told many times before (McCauley 1985; Sagne 1998), it will be retold here—however, with a focus on the mediality of mobility or the mobility of media. Image mobility and the mass of circulating images, which is often labeled with the somewhat pejorative term 'flood of images,' are not exclusively phenomena of the digital age. Nonetheless, the enormous traffic of digital images in our time makes it retrospectively evident that the processes of image distribution and practices of image sharing already played a decisive role in analog media, and that certain media phenomena should therefore be viewed from a different perspective—such is one of the basic theses of this volume. In the following, I will link the concept of circulation with that of dissemination, since circulation in this context does not mean a symmetrical circuit, as, for example, in the case of the system of blood circulation, but must be understood as the "asymmetrical, uncontrollable movement of a-centric circuits" (Bickenbach 2001, 123).[1] The 19th century in Europe and the USA seems to have been a particularly prolific era of mobility of the analog, because the circulation of goods, the expansion of free markets and freedom of trade, as well as the consumption and 'shrinking' of space through new means of transportation (Engell 1992, 20) gave this epoch a physiognomy of dynamics that was fundamentally reflected in economic, social and aesthetic fields (von Plessen 1993, 12). During that time, a downright revolutionary expansion of portrait photography occurred, bringing along major changes regarding "image logistics" (Rothöhler 2018)[2] in photographic production.

Two standardizations were responsible for the mass production of portraits. First, Frederick Scott Archer publicized the wet plate collodion process in 1831, which harmonized the various photochemical techniques for developing negatives for a certain period of time. This process enabled a much greater brilliance in the reproduction of photographs than that of Talbot's paper negatives. Daguerre's silver plate method created equally brilliant images, but, unlike the calotype, was not reproducible. Thanks to the wet plate collodion process, it was now possible to combine brilliant images with reproduction, and photography was subsequently standardized in its relationship to paper—making it a light and, thus, transportable,

mobile image. Since then, photographs have become, as Flusser puts it, "flyers" (Bickenbach 2001, 94):

> Even though the photograph remains a flyer for the time being and therefore can be distributed in the old-fashioned way, gigantic complex apparatuses of photograph distribution have come into being. Attached to the output of the camera, they absorb the images flowing out of the camera and reproduce them endlessly, deluging society with them via thousands of channels. Like all apparatuses, the apparatuses of photograph distribution also have a program by which they program society to act as part of a feedback mechanism. Typical of this program is the division of photographs into various channels, their 'channeling.' (Flusser 2000, 53)

It is no coincidence that Flusser's terminology and description are already reminiscent of experiences of circulation in the digital world.

Secondly, it was the standardization of the format of photography by Adolphe-Eugène Disdéri (1819–1889) that led to a true 'cartomania.' Even if the idea of the carte-de-visite format cannot be attributed to Disdéri alone, the credit for having decisively changed and advanced the development of photography still belongs to him (von Dewitz 1996, 99).[3] He recognized that if photography was to be used commercially on a large scale, its format had to be reduced and compressed, and easy reproduction had to be guaranteed. Only then would it be possible to reduce production costs and, thus, offer photographic services at a lower price, and only then would photography be attractive to a broader mass of people (Freund 1976, 67). As will be shown in the following, this also had a considerable impact on the aesthetics of the carte-de-visit.

## A Question of Representation

Thanks to a keen business sense, Disdéri had his technical innovations patented in 1854. One of his first actions was to reduce the format to just 9 x 6 cm, which corresponded to the usual business card size at that time, so that the term carte-de-visite refers less to its social use and more to the small format (Meyer 2019, 66; Krauss 2010, 28). Nevertheless, public authorities and companies often used carte-de-visite pictures as photo identification cards by sticking a full-size label on the back, which gave the user's credentials (Starl 2009, 52). Disdéri also used a special camera with four lenses, which was able to record four images on one half of a collodion wet plate simultaneously, or one after another; then the plate was moved with the help of a cassette, with which the second half of the plate could be exposed (Freund 1976, 68; Meyer 2019, 66). Afterwards, the albumen paper prints were produced, cut out and mounted on (initially quite inferior) sturdier

cardboard, so that finally eight single images could be made in a relatively short time. This resulted in a "formatting of the gaze,"[4] as Timm Starl puts it (1989, 82): "All efforts—as far as the image carriers were concerned—went towards creating uniform dimensions. But it was not until the beginning of the 1860s that a final size was found in the form of the carte-de-visite, which allowed the use of machines in cardboard and paper production, in plate manufacture and, to a certain extent, in camera construction" (Starl 1989, 83).[5] With these measures, Disdéri was able to considerably increase productivity and significantly reduce manufacturing costs at the same time (Krauss 2010, 28; Meyer 2019, 66).

This made portrait photography affordable not only for the upper classes, but also for large parts of the bourgeoisie (Freund 1976, 68). For Elisabeth A. McCauley it was precisely the compressed dimensions of the carte-de-visite that disengaged it from the courtly portrait: "The small size of the carte-de-visite photograph helped to break the traditional association of the full-length portrait with the aristocracy" (1985, 36). This new photographic achievement was celebrated as a "triumph of democracy and social equality" (H. d'Audigier, quoted from Starl 1991, 27),[6] as class differences on this level were now regarded as eliminated. Gisèle Freund also states: "The needs of the lower classes for representation and approximation were thus equally satisfied" (1976, 69).[7] Although this initiated a process of equalization in the production of portraits, it remained very selective at the level of those portrayed because the possibility of producing portraits still depended on the social stratum—the majority of the rural population and the proletariat were excluded from it (Bickenbach 2001, 93). Moreover, the process of equalization and democratization had not yet advanced to the same extent in other areas than media representation (von Dewitz 1996, 104). For the bourgeoisie was by no means as homogeneous as it might appear, and, at that time, it was competing with the nobility on the one hand and with the emerging proletariat on the other. It was precisely this social plurality and fragility of the bourgeoisie that nourished the desire for the portrait as the identification and self-affirmation of a class (Bickenbach 2001, 93).

However, precisely this function of the carte-de-visite as a medium of representation for the bourgeoisie has been and is still being questioned in recent research—not least because the intended individuality and factual conformity in the portraits ran counter to one another: even the photographers of the time complained about the stereotypical and conformist way of presenting people on cartes-de-visite. A small incident from this period, whose concrete circumstances and exact time are disputed[8]—although the existing portrait is actually the decisive factor—, deals with this question of representation (Fig. 6.1): Emperor Napoleon III is said to have had himself photographed by Disdéri in 1859—even before the troops left for Italy—in the manner of the carte-de-visite. Looking at this picture provokes wonder because one would have imagined a portrait of an emperor in a different way. Bodo von Dewitz describes the aforementioned photograph as follows:

> Although the third Napoleon, like his ancestor, presents himself in a distinguished posture—slightly turned out of the picture axis, his head and eyes turned towards the viewer, heightened by a few ingredients that are supposed to lend him dignity—he does not, unlike him [Napoleon Bonaparte, N.W.], present himself in soldier's or 'statesmanlike' clothes, but in a bourgeois street suit, like some well-to-do member of Parisian society. The background has also changed: instead of a festive hall or a battleground, we see a sort of private salon. And finally: compared to the enormous paintings of his uncle, his 8.5 cm x 6 cm pictures seem extremely modest, almost unsightly. (1996, 99–100)[9]

Even the emperor no longer represents himself 'according to his rank,' but is embedded in the same decoration as every other person photographed in carte-de-visit format.

While many contemporaries celebrated the new format and especially the "standard pose in a standard interior in standard size" (Adam 1996, 28),[10] some also complained about the decline of good taste. Contemporary photographer Henry Peach Robinson lamented the unimaginativeness of carte-de-visite photographs (Starl 1991, 27), which almost without exception embellished the image space with random columns, balustrades, consoles or pedestals. Likewise, the almost baroque-looking curtain must be understood as an obligatory accessory, regardless of which photo studio the pictures ultimately came from, because standardization had quickly become international (von Dewitz 1996, 104; Sagne 1998, 111). In his famous *Short History of Photography*, Walter Benjamin sardonically refers to the absurdity of columns standing on carpets and makes the following biting comment: "It was the time when those studios appeared with draperies and palm-trees, tapestries and easels, looking like a cross between an execution and a representation, between a torture chamber and a throne room . . ." (1972, 18). Compared to the conformity of the photographic representation on the front, the backs of the cartes-de-visite appear downright individualistic (Adam 1996, 28): on the cardboard, in addition to the name and address of the photo shops, one finds lithographed (after 1900 occasionally also photographed) views of the studio buildings or places known for tourism, medals, elaborate decorations as well as various optical devices and laboratory utensils, etc. (Starl 2009).

Despite the rather banal photographic aesthetic, the carte-de-visite triggered a new passion for collecting among contemporaries, so that even the Empress Elisabeth of Austria enjoyed the new fashion and collected numerous such cartes-de-visite in albums—even though it may at first seem strange that an empress should have joined this bourgeois leisure activity. In this regard, von Dewitz speculates that "the empress was not interested in collecting individual portraits or subjective representations, but in the similar scenarios of representation that soon found international validity" (1996, 104). The conformity of the presentational form ulti-


Figure 6.1: Napoléon III, Emperor of France, by Disdéri, albumen carte-de-visite, approximately 1859.

mately erases any notion of representation and individualism. Due to the stereotypical arrangement of persons and hardly distinguishable decorations, one picture equals the other. Matthias Bickenbach, too, describes the pictorial program of the

bourgeoisie as a paradoxical undertaking, since the bourgeoisie did not present itself individually but instead in a standardized manner (2001, 95). The self is no longer depicted and the portrait fails to represent, whereas a "representative portrait is based on the idea of the uniqueness of the autonomous individual. The portrait is a mirror of his or her personality, the individuality of the sitter is embodied in the individuality of the representation" (Meyer 2019, 65).[11]

## The Operational Portrait

Since the carte-de-visite gave up individual representation in favor of standardization, according to Meyer, we must speak of operational portraits:[12] "Operational portraits . . . are based on formats that regulate the production of large quantities of images, independent of the individual picture and its subject. Thus, before a picture is produced, its coordinates are already fixed: the people depicted enter a space of comparison in which the others are always already waiting" (Meyer 2019, 65).[13] The carte-de-visite breaks with the representational logic of the conventional portrait, since the standardization of the format and the technical production process shape the aesthetics of portraits prescriptively. At the same time, this redundant aesthetic is an expression of a visual culture that is oriented towards access, transmission and the exchange of goods. The individual single portrait becomes altogether less important in favor of serial photos:

> Operational images are a special case of technical-instrumental images; they are not only produced by an apparatus and optimized for specific purposes, they are also integrated into regulated processes of production, storage, distribution and evaluation, which aim to limit the contingency of possible interpretations in order to extract stable information from images. (Meyer 2019, 22)[14]

Although the terms 'storage,' 'evaluation' and 'information' could be associated especially with digital data sets, Meyer does not only mean digitally stored images but explicitly refers to the analog image worlds and data sets of photography. The technological intervention of the digital merely continues the initial conditions of analog photography. In line with this, Martin Lister also points to the stability of the photographic practices before and after the digital turn: "The difference between analog and digital image technology is only one factor within a much larger context of continuities and transformations. In short, in order to stress the significance of new image technologies we also have to look at how images are used, by whom, and for what purposes" (2004, 317). The contexts in which photography is used have indeed remained essentially untouched; it is only on the level of media convergence that digitization brought changes to photography. As early as 1895, Oliver Wendell Holmes emphasized the accelerated distribution and mobility in

photography: "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" (1895, n.p.). And: "The consequence of this will soon be such an enormous collection of forms that they will have to be classified and arranged in vast libraries, as books are now" (1895, n.p.).

From a technological point of view, digitization seems to have advanced primarily what has always been the practice of the 'public image' of photography, so that the long history of multiple uses and proliferation of photography in and through non-digital dispositives rather culminates in digitization (Wiedenmann 2019, 220). If seriality, reproduction and circulation are to be regarded as constitutive for photographic distribution phenomena, it makes sense to speak of "photography in the plural" (Geimer 2009, 139).[15] Already with the carte-de-visite, a circulation and dissemination of the photographs can be observed. As operational portraits, they were produced in large numbers and in processes based on the division of labor; due to their standardization, they were interchangeable in a certain sense, and exhibited a high degree of circulation in the social realm (Meyer 2019, 23).

In his study, Meyer draws on the theoretical-methodological concept of the actor-network theory (ANT) put forward by science historian Bruno Latour. According to ANT, agency cannot be attributed to a single entity, such as an image; instead, action must be understood as distributed between human and non-human actors, which form complex agential networks (2019, 23–24). Latour's term 'immutable mobiles' points in this exact direction, focusing on images' contribution to complex chains of action. In his essay "Visualisation and Cognition: Drawing Things Together," Latour attempts to explain the technological superiority of the West since modern times with the introduction and blatant use of such 'immutable mobile elements,' which mean: "*Anything* that will accelerate the mobility of the traces that a location may obtain about another place, or *anything* that will allow these traces to move without transformation from one place to another, will be favored" (1986, 13).

The term 'immutable mobiles' signifies that the mobilized data are transferred over space and time into other interpretational environments without the original information being changed or transcribed. Evidently, this applies also and in particular to photography, although Latour himself does not give it as an example—his objects of reference are primarily book printing, maps, statistical recording systems or accounting registers. Elisabeth Edwards, however, quite naturally regards photography as 'immutable mobiles' (2003, 342). Moreover, the ambiguity of the title "Drawing things together" explicitly indicates not only the moment of joining together but also that of drawing or visual representation (Wiedenmann 2019, 223). Latour himself, of course, already mentions the factor of "optical consistency" (1986, 7), i.e., the geometric organization of the image starting from central

perspective and the ideal-typical transformation of the three-dimensional world of objects into the flatness of the image, which he sees manifested above all in the prototype of all cameras, namely the camera obscura (1986, 9). The different groups of phenomena, which are decisive for the Western European advantage of knowledge and information since the Reformation, have in common that they allow for a massively increased operationalizability due to the interplay of mobility (transport), data persistence (stability) and combinability (accumulation, mixing). It is no coincidence that Latour's summary of the properties in question also reads like a description of corresponding photographic material qualities: "In sum, you have to invent objects which have the properties of being mobile but also immutable, presentable, readable and combinable with one another" (1986, 7). One could object that photographs can be 'modified' by changing the carrier medium, for example by varying the image detail, color values and contrasts—as the numerous examples of image manipulation, especially in political contexts, bear witness to. Of course, this applies equally to all the objects listed by Latour. However, this kind of reasoning fails to recognize the core of what Latour means by 'immutable': namely the omission of distortions, time-consuming transcriptions or translations, while at the same time maintaining (for the most part) the consistency of form and signs.

Operational portraits, Disdéri's invention of the carte-de-visite, and the associated standardization and reproduction possibilities can be considered as a "logistics of immutable mobiles" (Latour 2009)[16]: "They aim to increase the mobility of inscriptions, to ensure their stability, to multiply the possibilities of their combination and to optimize the techniques of making them readable" (Meyer 2019, 25).[17] However, changes in the media setting always also transform the perception of images and ways of dealing with them: "Only from a logistical perspective do images actually come into view in the plural: namely not as a diffuse 'flood,' but as elements in regulated and coordinated operations of arrangement and distribution, assessment and evaluation, assembly and linking" (Meyer 2019, 26).[18]

## The Miniaturization of the Format

Dealing with the historiography of operational portraits implies not looking at singular works, but observing the changes concerning the standardization of production, circulation and archiving. One aspect of this standardization relates to the format—the normalized measures that are reflected in the size and materiality of the image (Meyer 2019, 26–27). Meyer defines the format as follows: "In this sense, the term format here shall encompass all those simultaneously material and symbolic arrangements, divisions and subdivisions that turn image carriers into data carriers by framing them, structuring them and embedding them in larger technical ensembles such as albums or archives" (2019, 27).[19]

However, the increased mobility resulting from this is not reserved for technically reproducible or small formats only. As the art historian Jennifer L. Roberts has shown, an expansion of transportation can also be observed in the paintings from the 18th and 19th centuries. Due to changed material properties of the image carrier, especially the widespread introduction of the canvas from the 16th century onwards, pictures became more flexible. And also, for economic reasons, paintings became mobile to a greater extent and attracted attention as mobile goods (Rothöhler 2018, 4):

> Supposed that one wanted, during the eighteenth and nineteenth centuries, to engage in what we might now call "visual communication"—to disseminate, circulate, or otherwise transmit. This would have meant that a picture (a physical thing) had to be floated, rolled, or dragged across the surface of the earth. 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. (Roberts 2014, 1)

Referring to Roberts, Rothöhler emphasizes that the increasing transport movements require complex socio-technical infrastructures and logistics in order to mobilize, carry, pack and store the images (2018, 5). It is therefore hardly surprising that it is precisely these challenges posed by transport that draw attention to the materiality, format and also the weight of the images: "Everything is heavier when it has to be picked up and moved; pictures hefted through space necessarily become 'ponderous bodies'" (Roberts 2014, 8). Such heaviness and thingness become particularly apparent when pictures have to be moved (Roberts 2014, 9). In this case, Roberts refers to the transport of paintings. However, the telegraphic and photographic inventions of the 19th century fundamentally change the forms and speed of image movements, since pictorial distribution and production are now delegated to technical processes, making these images 'easy to move' (Rothöhler 2018, 5).[20]

While all these factors almost inevitably amount to a diminishment of the media in question, the miniaturization of the carte-de-visite, which will be described in more detail below, can hardly be understood without the counter-tendencies within the media constellations and visual culture of the 19th century. According to Erkki Huhtamo, this period is characterized by a "'Gulliverization' of the visual" (2009, 20), which is paralleled by the development of new image formats: Not only miniaturizations but also enormous enlargements of visual products emerged. Through economic developments in the cities and optimizations in printing tech-

nology, it was possible to produce chromolithographic posters and advertisements in various colors. Increasingly, graphic designers also learned to handle very large formats, reduced the text portions and focused on trademarks that could be recognized from a distance (Huhtamo 2009, 19). As particularly gigantic picture installations of the 19th century, panoramas and dioramas, which completely immersed the viewer thanks to their enormous size, became very fashionable (Huhtamo 2009, 20). These immersive structures and the sociological function of the panoramas, to make things sensually perceptible and concretely visible, bring such images closer to the cinema (Engell 1992, 36), whose rise led to the decline of the panorama culture at the beginning of the 20th century. Although the size of the panoramas seems to make their mobility unlikely, these images were often designed for circulation. For example, Aston Barker's depiction of Napoleon's defeat at Waterloo, one of the most lucrative panoramic images of the early 19th century, was even shipped to America, where it traveled and was shown until it fell from the wall in shreds. By implication, transport and circulation inscribe themselves into the material itself. The changing programs of the panoramas were intended to keep the public's attention. Therefore, an international network for the exchange of panoramic screens was created. For this purpose, a certain standardization of the format was necessary, since only the same dimensions of screens and rotundas could ensure the functioning of an international network system. On a social level, the changing image programs of the panorama rotundas corresponded to the increasing mobility of professional people who were free to pursue a trade, so that professional wanderings became commonplace (von Plessen 1993, 13–17).

A look at today: The panorama *Dresden during the Baroque* by Yadegar Asisi (Fig. 6.2), which was created in the 2000s and reworked again, reflects the pictorial movements in earlier centuries. One detail of the panorama shows how a painting wrapped in sheets is being unloaded from a horse-drawn carriage. August III had purchased Raphael Santi's *Sistine Madonna* for a great deal of money; despite the very unfavorable winter weather, the painting was transported in a box across the snow-covered Alps to Dresden in January 1754, while being stretched on a frame (and curiously not rolled) (Asisi 2016, 59). This giant mobile painting (the Dresden Panorama has also been exhibited in Pforzheim and Rouen) deals with the pictorial movements of—still quite large—paintings in the 18th century, and, thus, with trajectories that Roberts traced in her above-mentioned work.

In addition to the proliferation of gigantic images, there was also a countermovement: shrinking, miniaturization and compression of formats—the images became Lilliputian (Huhtamo 2009, 19–20). Chromolithography and photographic processes led to the production of images that were smaller than usual and could be disseminated and distributed en masse, for example in the form of printed images, stereoscopic photographs and also cartes-de-visite. Precisely because of the material properties of the physical image carrier and its standardized formatting, the

Figure 6.2: Raphael Santi's Painting *Sistine Madonna* in the panorama *Dresden during the Baroque* by Yadegar Asisi.

carte-de-visite was particularly easy to move and was conceived as a visual medium of mobility—or, to put it with Holmes, its 'form is cheap and transportable.' The format and materiality were also responsible for the very low weight of cartes-

de-visite, which already suggests its circulatory nature due to its easy transportability—a fact that has received little attention in research to date: "Quite possibly not a single line in any history of photography addresses the weight of images. It is, however, a crucial question: it determines their mobility and thus their propensity for exchange" (Cheroux 2019, 10). Even though the low weight is not explicitly mentioned as a reason for easy transportation, the materiality of photography is nevertheless brought into focus: "the mobility of pictures and other photographic items was embedded in photography's material character. As material objects, photographs are able to circulate and to challenge distance of space" (Natale 2018, 43). According to Natale, early photography was already considered a circulating commodity and a modern technology that was able to paradigmatically change the entire structures of communication:

> Photography was conceived as a medium that put images in movement, allowing pictures taken from reality to be carried, marketed and transported. In fact, photography was from the very beginning a medium of communication in the strictest sense of the term. Putting images taken from reality in movement, and allowing them to circulate across space, photography was perceived and used as pertaining to a range of new technologies that were transforming the very functioning and conditions of human communication. (2018, 35)

It is obvious that distribution and circulation possibilities would accumulate especially for the carte-de-visite, due to their small size and manifold standardization. Even before Disdéri, Edouard Delessert and his Parisian friend Count Olympe Aguado had the idea to print small portraits on business cards and thereby to replace the name. This way, everyone should carry a series of these small portraits of themselves, so that instead of exchanging the usual social rituals, one could (re)present oneself through a portrait appropriate to the occasion—as the French photography critic Ernest Lacan reported:

> Thus, for a ceremonial visit, the print would represent the visitor with his hands imprisoned in spotless gloves, his head slightly inclined, as for greeting, his hat resting graciously on his right thigh. According to etiquette, if the weather were bad, an umbrella faithfully reproduced under the arm of a visitor would eloquently declare the merit of his walk. (Ernest Lacan quoted from McCauley 1985, 28)[21]

Although this form of use of the carte-de-visite did not prevail, it was already intended as a series of mobile portraits which a person should always carry with her. Shortly after the publication of the two gentlemen's idea, Disdéri applied for a patent for the carte-de-visite. It was not meant as a communication substitute in the field of manners, but in the end, it turned out to be just as formulaic. The miniature format not only contributed to mobility and circulation, but also to the

standardization of aesthetics, which, for reasons of pictorial proportions alone, no longer obeyed a pure logic of representation. For the reduced size of the format and the mostly full-figure shot meant that the sitter's face was quite miniscule. John Tagg explains: "Carte-de-visite photographs were made to a formula. Posing was standardised and quick, and the figures in the resultant pictures were so small that their faces could not be studied" (1988, 50). Hence, miniaturization almost inevitably frees the carte-de-visite from the 'burden of representation' (Tagg 1988), since in a certain sense, the portrait's resemblance, which aims at harmonizing the nexus of the outer features with the character of the person depicted, is suspended. This brings us back to the operational portrait, which also shows individuals, but without aiming at a 'living similarity' between the image and the original (Meyer 2019, 18–24). In the case of the carte-de-visite, this similarity is hardly possible because of their size anyway.

> Operational portraits . . . are not directed at the gaze of an individual who recognizes a living counterpart in the picture, but at a specialized and disciplined gaze for which the picture becomes an abstract operating surface that can be dissected, filtered and measured. Therefore, the question of portrait's resemblance, understood as a characteristic overall effect that goes beyond the addition of mere pictorial details, is also less significant than that of the relation of the individual picture to other possible and comparable pictures. (Meyer 2019, 22)[22]

However, the question is raised of what function the carte-de-visite actually fulfills, when it no longer seems to be governed by the logic of representation. This function is compensatory: the small pictures and objects, which found their way into the salon, started to give the inhabitants an illusion of control that had increasingly been lost in the public sphere. If everything outside became faster, larger and more confusing, the private home offered a measure of the anthropomorphic and organized (Huhtamo 2009, 20). While images had become ever more gigantic in public space—for example in the case of billboards and panoramas—images shrank to miniature size at home. Although on the one hand the triumph of miniature and collectible pictures can be understood as the increasing intrusion of public space into the private sphere, on the other hand, it is precisely the carte-de-visite that loses every threatening aspect and instead offers a familiarity that is created by its reduction in size (Starl 1991, 123–124). The miniaturized images were not only palpable and thus tactilely perceptible but could be carried around like fetish objects in a wallet. In Walter Benjamin's work, similar considerations can be found regarding the relationship between mobility, format and tactility:

> Namely, the desire of contemporary masses to bring things 'closer' spatially and humanly, which is just as ardent as their bent toward overcoming the uniqueness of every reality by accepting its reproduction. Every day the urge grows stronger

> to get hold of an object at very close range by way of its likeness, its reproduction. (1969, 5)

To get hold of things and to re-establish manageability and contact was obviously one of the central reasons for the enthusiasm for the cartes-de-visite. Especially the inhabitants of big cities could no longer experience their environment as a regulated whole. Instead, fragmentation, abstraction, the unmanageable movement of goods as well as permanent mobilization and circulation challenged the experiences of reality that had been gained until then. Therefore, the carte-de-visite was the result and a child of these modern processes, since the visiting card could only emerge in the course of technical reproducibility, standardization, division of labor and circulation of goods, but at the same time it also figured as a form of compensation for these changes, which were often perceived as unreasonable (Engell 1992, 38).

## Concrete Lines of Movement: Transporting, Collecting, Sharing

While my observations on standardization have so far been mainly related to the format, I will now focus on the conventionalized use of the carte-de-visite and on its technical, economic and social networks. Meyer's additional term, 'protocol,' which draws on Alexander Galloway, is useful in this regard: "Every formatting limits the contingency of possible images, every protocol stabilizes the links between images, data and bodies" (2019, 28).[23] This means that formats and protocols are mutually dependent on each other and produce higher-level logics of organization. In the following, I will delineate the logics involved in distribution and circulation movements. The re-contextualization of images resulting from various dispositives and networks is also of particular interest.

The photographer's studio will serve me as a starting point. Although Disdéri tells of the intimacy of the photographic act in his notes, he—as well as many other photographers—is in fact rather a manager of mass production in which standardized poses and a stock of the ever-same accessories are combined and recombined (Meyer 2019, 71–72). Most photo studios possessed a rich fund of decorative elements, which imitated bourgeois domestic culture and provided the insignia of the bourgeois—the book, the instrument, etc. Soon, this led to new business models, inasmuch as decor, such as balustrades and pedestals, were mass-produced by specialized suppliers from wood and papier-mâché, and companies produced backdrops that were interchangeable and circulated between the studios (Meyer 2019, 78). Thus, mass photographic production stimulated further professionalization and factory-based manufacturing processes in related areas, which in turn resulted in further standardization of the carte-de-visite on the aesthetic level. While

the profession of the portrait photographer had previously been a rather lonely one, Disdéri already employed over 60 people at his weddings. He devoted himself to celebrity clients, while other operators took over the day-to-day business following his instructions, and a large technical staff helped to cope with mass production. The Janus-faced character of the medium, on the one hand as an optical recording apparatus and on the other hand as a chemical process, also finds its way into the dual nature of the studio: in the 'glass house,' i.e. in the daylight studio, the photograph is taken, while the photographs are developed in the darkroom (Meyer 2019, 72). Bickenbach describes the photo studio of that time as a heterotopic and complex place with various functions, since divergent communicative structures are amalgamated here. The 'glass house' is the place of transparency and public access, a kind of salon for encounters, while the darkroom stands for the secret and the area accessible only to staff (Bickenbach 2001, 98). If possible, the darkroom should be directly connected to the photographic studio in order to keep the distances as short as possible and to guarantee an efficient interlocking of the different steps in the process. Meyer sketches two circuits: the route of the customers and the path of the photographic plate. After looking at the sample books in the reception room, the customers had themselves fitted out in the cloakroom according to the usual iconography and were then photographed in the bright studio. In contrast, the photographic plate was passed on to the auxiliary staff backstage to be developed, copied and archived. The plate remained with the photographer, while the paper prints mounted on cardboard were brought back to the light area and handed over to the customers. This separation of space and production structure also reflected the hierarchy of the division of labor, in the sense that the operator in the glass house interacted and bowed and scraped with the customers, whereas the laboratory assistants took over the chemical routines in the darkroom and were not able to communicate with the public (Meyer 2019, 72–73). In addition, the studio also became an exhibition space and resembled the soaring department stores and shopping temples as places for the circulation of commodities. The photo studio now also had shop windows—new *urban screens* in which common portraits, but also photographs of celebrities were displayed. The latter in particular were read as proof of the studio's high quality and its cultural and social status. The public images of famous people—emperors, actors and dancers—could be disseminated and acquired through the studios, but also through publishers and bookstores, which further explains the enormous increase in sales figures for photography in general and for carte-de-visite in particular (Bickenbach 2001, 99–100).[24]

The pirated copies made of portraits of famous people show how competitive the market was in this area. Since questions of copyright were not yet clarified, products by competitors could simply be photographed and circulated as reproductions of a reproduction (Adam 1996, 30; Meyer 2019, 74).[25] Around 1860, carte-de-visite pictures of famous people were sometimes sold 1000 times a day. The

studios produced portraits of citizens as well as photographs of celebrities. The customers, in turn, wanted to have their own portrait made and to distribute it to friends, and at the same time to own portraits of political and cultural notabilities. Thus, these small pictures became an important branch of industrial commodity capitalism. "In view of this almost 'unlimited picture gallery,' selection and collection seem to be the necessary consequence of the flood of images" (Bickenbach 2001, 96).[26] For the photographs were offered both individually and in collected works: the photo or collector's album therefore resulted directly from this dissemination, constituting a new archiving technique and a concrete place where the abstract space of comparison, created through technical (re)production and standardization, was manifest (Fig. 6.3).

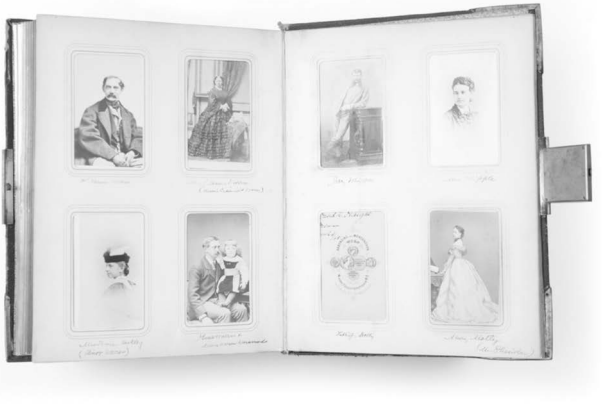

Figure 6.3: Carte-de-visite album, "Photograph Album of John Collins Warren 1842–1927."

As a format, the album was also largely standardized and represented a mass-produced storage medium for the prints (Meyer 2019, 79). It was bound in leather; its individual pages were mostly squared and the cards only had to be inserted into the pages.[27] The photograph was pushed through a slit and then appeared on the page that was aptly called the 'scenery.' The cardboard sheets with the carte-de-visite photos were sometimes trimmed by customers at two or four corners so that they could be inserted more easily into the sceneries of the albums (Starl 2009, 28)—the practice of inserting photos thus leaves material marks on the pictures. As a dispositive, the album also changed the reception of photography: the albums were displayed as decorative objects, preferably in the salon, where they could be

presented to visitors (Meyer 2019, 79). They were now literally in one's hand, allowing the images to be experienced tactilely and allowing a close-up view, which of course suited the small format. In contrast to the distant presentation of portraits on the wall, the cards could be touched and continually exchanged.

Structurally, the album was based on a variable arrangement: since the images were not glued to the pages, they were loosely coupled elements that could be rearranged, reassembled and supplemented (Bickenbach 2001, 100–101). Entirely designed for mass production, minimum orders of 25 per photo motif were not uncommon, so that images continued to circulate and be exchanged in loose friendship networks—they were considered, so to speak, the "'currency' of friendship and community" (quoted from Meyer 2019, 80),[28] as an American article from 1867 explains. Portraits of celebrities were added to family and one's own portraits, thus allowing images of private and public space to diffuse into one another. "As a genre of mixing, the album is a place of recombination of role models, both one's own and others', and thus it becomes a space for the restabilization of photographic circulation" (Bickenbach 2001, 104).[29] Collecting the cartes-de-visite and storing them in albums, however, did not represent an end point of circulation, but only a further stage in the process of exchange and transmission. The albums themselves became a driving force behind the industrial circulation of goods over several decades, generating numerous patents on fasteners and boosting the import of leather from overseas. Finally, specialized albums on a wide variety of topics were introduced and the circle of avid collectors became differentiated accordingly (Bickenbach 2001, 101). Such collectible pictures were not only distributed by publishers, but also by art or paper dealers and other shops dealing in photographic articles (Starl 2009, 88). Whole series were created, promoting their accumulation, collecting, exchange and distribution. The relationship between photo albums and carte-de-visite prints alone corresponded to an interdependent system that favored dissemination: while the photographs wanted to be stored and viewed, the scrapbooks waited to be filled up.

One specific feature was prints of photos which were added to a manufacturer's individual products or could be ordered in tranches; they were stuck by the buyers into the corresponding collector's albums, in which each picture could be assigned to a labeled empty space (Starl 2009, 126–127)—similar to today's popular sticker albums by Panini.[30] The close connection between the general circulation of goods and the trajectories of photographs called for photographs in a very small format in order to ensure joint dissemination: "Another interesting example of the inclusion of photography in a commercial commodity of wide circulation is the eight thousand picture cards produced by Ogden's Tobacco company and distributed with packs of cigarettes, which promised to offer a 'panorama of the world at large'" (Natale 2018, 42–43).[31]

In addition, the carte-de-visite was linked to another distribution network, namely that of the postal service. The latter was very often used in order to receive, exchange and give away pictures. As Henkin documented, money and photographs were the things most often sent by post in the middle of the 19th century (Henkin 2018, 38–55; Natale 2018, 43). Referring to Henkin, Simone Natale clarifies how important and popular this kind of photographic 'participation' was: "In fact, . . . receiving photographs of a son could be such a powerful form of symbolic contact that it came to be considered 'as good as a short visit'" (2018, 40). The enormous distribution and dissemination of photography was enabled by a coupling of different organizational structures and networks; it could be fed easily into all these structures mainly because of its small format and light weight. Finally, it can also be observed, as the trimmed underlaying cards already show, that the mobility of the photographs, their trajectories and their value as exchangeable articles simultaneously left traces on the tactile surface, and that media mobility has thus reinscribed itself into the mobile matter in the form of indices of use. Many of the carte-de-visite portraits still available today show various traces of wear and tear, such as worn edges, torn cardboard bases or stains.

From the beginning, photography was a medium based on circularity, and it still is today: "And from the beginnings of mass participation in the ritual of photographic portrait exchange, such portraits were media of communication, not simply media of representation or reproduction. . . . The light, miniaturized impressions of human faces that flooded . . . cities at midcentury were built to travel, to circulate, and to communicate" (Henkin 2018, 55). In the case of the carte-de-visite, it was precisely the small, compressed format that must be understood as an innovative step towards the acceleration and circulation of photography, or as Michael Gamper and Ruth Mayer write about the small format:

> For a long time now, media and technical apparatuses have been helping to bring the new into the world ever faster and in ever more compressed form. The career of the short formats is closely connected with cultural achievements of the 17th century, which rapidly gained momentum until the 19th century: with the development of a national and transnational press system, with the formation of global public spheres and markets, with scientific professionalization and with the emergence of new media technologies. In the course of this reorganization of the communication and information economy, formats that promised to respond to the unknown and the new in a compact and compatible manner gained in importance (Gamper and Mayer 2017, 7).[32]

The long path of the photographic image from its beginnings, through the various reproduction and input technologies, to today's omnipresence on computer screens, mobile phone displays and projection screens can be traced, as I have suggested in this article, as a process of massive increase in dispositives and show-

places in which and on which the photographic dataset appears—as a history of photography, which conceptualizes digitization not as a caesura, but only as a further proliferation of the photographic in its manifold manifestations (Wiedenmann 2019, 221).

*Translated by Henning Persian*

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## Notes

1 "asymmetrische, unkontrollierbare Bewegung a-zentrischer Kreisläufe" (Bickenbach 2001, 123).

2 "Bildlogistik" (Rothöhler 2018).

3 The basic idea probably goes back to the photographer Louis Dodero, who thought ahead of his time that small-format photos could replace the cumbersome descriptions of people on passports and hunting licenses and supplement signatures in business transactions. In his letters, he placed a small portrait of himself next to his signature (Baier 1965, 506).

4 "Formatisierung des Blicks" (Starl 1989, 82).

5 "Alle Anstrengungen gingen—was die Bildträger betraf—dahin, einheitliche Abmessungen zu schaffen. Doch erst gegen Beginn der 60er Jahre fand sich mit dem Visitformat eine endgültige Größe, die in Karton- und Papiererzeu-

gung, in der Plattenfabrikation sowie in gewisser Hinsicht auch im Kamerabau den Einsatz von Maschinen erlaubte." (Starl 1989, 83)

6 "Triumph der Demokratie und der socialen Gleichheit" (H. d'Audigier, quoted from Starl 1991, 27).

7 "Repräsentations- und Angleichungsbedürfnis der unteren Schichten waren damit gleichermaßen befriedigt." (Freund 1976, 69)

8 "Nadar's story that Napoléon III stopped at Disdéri's studio while leading French troops to Italy in May 1859 and so catapulted the photographer to celebrity is not confirmed by reports of Napoléon's movements in biographies and the Moniteur universel. Napoléon's route on May 10, 1859, from the Tuileries to the Gare de Lyons did not take him near Disdéri's studio, and eyewitness accounts of the progress of his carriage through applauding crowds fail to mention a break in the parade. Furthermore, the emperor left the capital at six in the evening, well after the time that a portrait could possibly have been taken." (McCauley 1985, 45)

9 "Zwar präsentiert sich der dritte Napoleon wie sein Vorfahre in repräsentativer Haltung, leicht aus der Bildachse gedreht, den Kopf und die Augen dem Betrachter zugewandt, erhöht durch einige Zutaten, die ihm Würde verleihen sollen. Aber er zeigt sich anders als dieser [Napoleon Bonaparte, N.W.] nicht in Soldaten- oder 'Staats'-Kleidung, sondern im bürgerlichen Straßenanzug wie irgendein Wohlbetuchter der Pariser Gesellschaft. Auch der Hintergrund hat sich geändert: Statt eines festlichen Saals oder des martialischen Kriegsaufzugs erblicken wir eine Art privaten Salon. Und schließlich: Im Vergleich zu den gewaltigen Bildnissen seines Onkels muten die seinen im Format von 8,5 cm x 6 cm ausgesprochen bescheiden, beinahe unansehnlich an." (von Dewitz 1996, 99–100)

10 "Standardpose in einem Standardinterieur in Standardgröße" (Adam 1996, 28).

11 "Das repräsentative Porträt basiert auf der Idee der Einzigartigkeit des autonomen Individuums. Das Bildnis ist Spiegel seiner Persönlichkeit, die Individualität des oder der Dargestellten verkörpert sich in der Individualität der Darstellung." (Meyer 2019, 65)

12 Meyer's concept of operational portraits is inspired by Harun Farocki's terminology of 'operational images,' which Farocki uses to describe a new type of technical image. Images such as those used in satellite reconnaissance, surveillance, or missile guidance systems, which intervene very concretely in action sequences and no longer primarily understand humans as perceptual actors, but are integrated into further technical and automated action sequences (Meyer 2019, 22).

13 "Operative Porträts . . . basieren auf Formaten, die unabhängig vom einzelnen Bild und seinem Gegenstand die Produktion großer Mengen von Bildern regu-

lieren. Bevor also ein Bild entsteht, sind dessen Koordinaten bereits festgelegt: Die Abgebildeten begeben sich in einen Raum des Vergleichs, in dem immer schon andere warten." (Meyer 2019, 65)

14 "Operative Bilder sind ein Spezialfall technisch-instrumenteller Bilder, sie werden nicht nur apparativ erzeugt und für spezifische Zwecke optimiert, sie sind auch eingebunden in reglementierte Prozesse der Herstellung, Speicherung, Distribution und Auswertung, die darauf zielen, die Kontingenz möglicher Interpretationen zu beschränken, um aus Bildern stabile Informationen zu extrahieren." (Meyer 2019, 22)

15 "Fotografie im Plural" (Geimer 2009, 139).

16 This is the title of Latour's paper "Logistik der immutable mobiles," published in German in 2009.

17 "Sie zielen darauf, die Mobilität von Inskriptionen zu erhöhen, ihre Stabilität zu sichern, die Möglichkeiten ihrer Kombination zu vervielfachen und die Techniken ihrer Lesbarmachung zu optimieren." (Meyer 2019, 25)

18 ". . . erst unter einer logistischen Perspektive kommen Bilder tatsächlich im Plural in den Blick: nämlich nicht als diffuse 'Flut,' sondern als Elemente in regulierten und koordinierten Operationen der Anordnung und Verteilung, Erfassung und Auswertung, Versammlung und Verknüpfung." (Meyer 2019, 26)

19 "In diesem Sinne soll der Begriff des Formats hier all jene zugleich materiellen wie symbolischen Anordnungen, Aufteilungen und Gliederungen umfassen, die Bildträger zu Datenträgern werden lassen, indem sie sie rahmen, strukturieren und in größere technische Ensembles wie Alben oder Archive einbetten." (Meyer 2019, 27)

20 In the middle of the 19th century Giovanni Caselli invented the pantelegraph—a kind of forerunner of the fax machine. "The apparatus is—and this is remarkable—precisely the first apparatus to transmit images commercially. . . . The image is initially thought of as handwriting and as a written image in the form of signatures, scenarios of use such as the transmission of plans are added later, portraits and ornamented greeting cards are telegraphed for demonstration purposes." ["Der Apparat ist—und das ist ja bemerkenswert—eben der erste Apparat, der kommerziell Bilder überträgt. . . . Das Bild wird zunächst als Handschrift und als Schrift-Bild in Form von Unterschriften gedacht, Nutzungsszenarien wie das Übertragen von Plänen kommen später hinzu, zu Demonstrationszwecken werden Porträts und ornamentierte Grußkärtchen telegraphiert."] (Zons 2015, 16) The pantelegraph was an electromechanical device used to receive and transmit image information line by line via telegraph lines. An electrochemical process was used to generate images. Caselli had his invention patented in 1855. In the patent,

he also described very extensively his ideas for the use of the pantelegraph (Zons 2015, 57).

21 In 1861, under the heading "Correspondence from Paris" ("Correspondenz aus Paris") in the journal *Photographisches Archiv* (Vol. 2, p. 260), the author referred to these ideas of Mr. Delessert and Aguado. The correspondent was Ernest Lacan, who also mentioned this episode in an article in *La Lumiere* (Peters 2004, 169).

22 "Operative Porträts . . . richten sich nicht an den Blick eines Individuum, das im Bild ein lebendiges Gegenüber erkennt, sondern an einen spezialisierten und disziplinierten Blick, für den das Bild zur abstrakten Operationsfläche wird, die sich zergliedern, filtern und vermessen lässt. Daher ist auch die Frage der Porträtähnlichkeit, verstanden als charakteristische Gesamtwirkung, die über die Addition bloßer bildlicher Details hinausgeht, weniger bedeutsam als die der Relation des Einzelbildes zu anderen möglichen und vergleichbaren Bildern." (Meyer 2019, 22)

23 "Jede Formatierung begrenzt die Kontingenz möglicher Bilder, jedes Protokoll stabilisiert die Verknüpfungen zwischen Bildern, Daten und Körpern." (Galloway 2019, 28)

24 In the case of portraits of famous people, there was also a differentiation of the market. While Nadar's focus was on artists, scholars and bohemians, princes, dignitaries and statesmen tended to go to Disdéri and Mayer & Pierson, while Pierre Petit photographed bishops and celebrities (von Dewitz 1996, 100; Bickenbach 2001, 98; Sagne 1998, 106).

25 This also means that the actual author of the photographs did not receive any remuneration. This legal uncertainty existed in the early phase of photography until different copyright laws came into force in the individual countries (Adam 1996, 30). The problem of the legal situation also arose, among other things, from the question of whether photography must be understood as art, as an original product of intellectual work, or as a merely mechanical and apparative form of reproduction (Meyer 2019, 74).

26 "Auswahl und Sammlung scheint angesichts dieser fast 'uneingeschränkten Bildergalerie' . . . die notwendige Konsequenz der Bilderflut zu sein." (Bickenbach 2001, 96)

27 At the beginning of the 1860s, the slip-in albums were initially only designed for one carte-de-visite picture per page. By the end of the decade, however, the albums mainly had sceneries for two or four pictures per page (Starl 2009, 97).

28 "'Währung' der Freundschaft und Gemeinschaft" (Meyer 2019, 80).

29 "Als Genre der Mischung ist das Album Ort der Rekombination von Vorbildern, eigener wie fremder, und damit wird es zum Raum der Restabilisierung fotografischer Zirkulation." (Bickenbach 2001, 104)

30 Another feature of the carte-de-visite is the mosaic card, which Disdéri patented in 1863. This card combined several portraits of different people into one picture. Thus, for example, the portraits of all the marshals of France or the cabinet ministers were united on one card. A particularly original montage by Disdéri shows the legs of the dancers of the Paris Opera. Here, miniaturization had reached its peak as the sitters' heads—or other parts of the body—were often the size of a pin. Such mosaic cards were lucrative advertising material for a photo studio (Sagne 1998, 112).

31 In Nazi Germany, Joseph Goebbels established a company called *Cigarette Picture Service* [*Cigaretten-Bilderdienst*] to distribute Lilliputian pictures on the subject of 'Hitler's life' or Nazi uniforms. Advertising strategies and collecting passion were thus coupled to the Nazi ideology (Huhtamo 2009, 20–21).

32 "Schon seit langem tragen mediale und technische Apparaturen dazu bei, dass das Neue immer schneller und komprimierter in die Welt getragen wird. Die Karriere der kurzen Formen hängt eng mit kulturellen Errungenschaften des 17. Jahrhunderts zusammen, die bis zum 19. Jahrhundert rasant an Fahrt aufnahmen: mit der Entwicklung eines nationalen und transnationalen Pressewesens, mit der Formation globaler Öffentlichkeiten und Märkte, mit der wissenschaftlichen Professionalisierung und mit der Herausbildung neuer Medientechnologien. Im Zuge dieser Neuordnung der Kommunikations- und Informationsökonomie gewannen Formate an Gewicht, die auf das Unbekannte und Neue kompakt und kompatibel zu reagieren versprachen." (Gamper and Mayer 2017, 7)

# 7. Grainy Days and Mondays: *Superstar* and Bootleg Aesthetics[1]

*Lucas Hilderbrand*

A beloved and moving oddity, *Superstar: The Karen Carpenter Story* (1987) uses dolls to portray 1970s sibling supergroup the Carpenters' rise to fame and singer Karen Carpenter's struggle with anorexia. Filmmaker Todd Haynes presents the Carpenters' music and personas as conflicting with their tumultuous historical context and with their own lives and desires. *Superstar* strips away the surface sheen of media images and exposes the human frailty behind easy (if often melancholy) listening. Originally a 16 mm film, *Superstar* has been prohibited from legitimate distribution since 1989 as a result of its unauthorized use of the Carpenters' music. And yet this featurette has survived through bootleg circulation and launched Haynes's career as an acclaimed filmmaker. VHS tapes of *Superstar*, which proliferated through multiple generations of dubbing, betray the fuzzy images and warbled soundtracks of analog video reproduction—what I call bootleg aesthetics or the aesthetics of access.

Appropriated music and images function expressively within the film to reproduce the mass-mediated context of the Carpenters' work and to re-present a cultural memory of the 1970s. Videotapes of the film, by extension, inscribed a bootleg aesthetic that exhibits the audience's engagement in a clandestine love affair—watching, sharing, and copying the illicit text so that viewers' reception of *Superstar* was historically, perceptually, and emotionally reshaped. Videotape duplication of the work formally changed the text so that its thematic concerns—distorted mass media and their relations to subjective and bodily breakdown—were rendered on the surface; the image loss with each successive VHS-to-VHS dub reflected Karen's subjective and bodily wasting aesthetically so that her disappearing anorexic body became manifest in the material information loss.

Significantly, this analog duplication also recorded the cult audience's participation in re-producing *Superstar*. Bootleggers' participation is not limited to distribution but is also aesthetic and affective. Because the tapes circulated primarily through personal connections, they also became souvenirs of relationships. This chapter presents the film's production, exhibition, and legal histories prior to examining the bootleg aesthetics inscribed onto videotape reproductions.

## Yesterday Once More: Analog Videotape Aesthetics

Although perhaps most commonly used to play commercial releases of Hollywood movies, workout videos, and porn tapes, home video was introduced as a *blank* format for the purpose of recording television without permission. As I argue through the concept of bootlegs' aesthetics of access, the specificity of videotape becomes most apparent through repeated duplication, wear, and technical failure: that is, we recognize videotape as tape through its inherent properties of degeneration.[2] Magnetic tape's core functions are recording and erasing, but it is through errors, muck-ups, and decay that users may become most conscious of the tape. Videotape recorders erase tapes before re-recording them, and through human negligence or mechanical failure and quirks, sometimes programs get accidentally taped over or don't get recorded at all. Most home tapers experienced the frustration of realizing that they had taped over part of a recording that they meant to save, either because the cassette hadn't been labeled or cued properly or because the deck was programmed incorrectly. On playback, the viewer may experience jarring accidental jump-cuts between unrelated texts and only then realize that one thing has been taped over another. In addition, if commercials are elided or videos are edited using two VCRs rather than higher-end postproduction decks, the transitions between recordings will often produce snowy glitches, squirmy images, or sound distortion as the VCR heads recalibrate. Audiences learned to ignore analog video interference and to filter out the mediations and artifacts, but distortion was always present and perceptible.

Analog tape emerges as visible and audible through the way the image and soundtrack degenerate due to (repeated) reproduction or aging. Each format has a specific aesthetic of failure, and analog videotape has unique modes of decay. Old phonographs betray crisp crackles, and used celluloid prints bristle with pops, scratches, and splotches; digital media's "corruption" skips, freezes, exhibits blocky interference patterns, or becomes wholly unreadable and inoperable. In contrast, videotape's wear tends toward the softening interference of muffled rainbow flares (called video moiré), skewed images at the top and bottom of the frame (called flagwaving or skew error caused by stretched or distorted tapes), white specks (called dropout), lines of distortion (called noise bars), exaggerated pixels, jittery framing, and muted sounds. In more extreme cases, tapes damaged by VCRs can cause tracking problems or trigger a default blue screen if the heads cannot detect a video signal. I consider these technical faults to be indexical evidence of use and duration through time. Here, the technology becomes a text, and such recordings become historical records of audiences' interactions with the media objects, whether through use (stress from repeated contact between the tape and the VCR heads) or reproduction (analog softening of image and sound).

Analog media, for which duplication involves degeneration, reflect an aesthetic of access. The altered look and sound of a text through its reduced resolution is both a trade-off for our ability to engage with it and indexical evidence of its circulation and use. We see this in analog photocopies, microfilm, videotapes, and even low-resolution digital PDFs and streaming videos. And although I am hesitant to make reference to the overly cited (though inspiring) Walter Benjamin, it strikes me that this is a source of his ambivalence about reproductions of art in the modern age. Artworks lose their physical presence, ritual function, and authenticity when they are reduced to images, yet such images vastly expand the potential audience that may come to learn from and about them. Reproductions exchange aura for access (Benjamin 1969, 217–252). In addition, if we think of aesthetics as relational, technologies of access, such as videotape, alter the reception of texts by opening up the audience-text dynamic; audiences can review, fast forward, pause, or simply turn videos off. In some cases, videotapes are presumed to be empty vessels—storage devices to save television broadcasts, films, or video art—and yet the technology necessarily mediates not only access but also aesthetics. My dual emphases on both videotape's reproductive innovations and its decay may seem contradictory, even counter-intuitive. But I suggest we cannot experience one without the other.

The aesthetics of videotape are not merely matters of formalist specificity but also engaged in broader social and cultural issues of circulation, reception, historiography, and regulation. Bootlegging illuminates the aesthetics of analog videotape because it so often involves multiple generations of reproduction and offers practical models that have challenged, expanded, or provided alternatives to existing intellectual property or distribution paradigms. I define bootlegging broadly, to include most noncommercial practices of timeshifting (recording broadcasts off-air for later viewing), tape dubbing, importing, and sharing of media content that is not reasonably available commercially. Bootlegging functions to fill in the gaps of market failure (when something has not been commercially distributed), archival omissions (when something has not been preserved for historical study), and personal collections. In the digital video age, bootlegging also includes excerpting and sharing culturally significant or newsworthy corporate media clips. Despite the often negative or criminal connotations of the term, I use "bootlegging" to reclaim its productively illicit meanings, its intoxicating pleasures, and its amorous relationships between texts and audiences. In distinction, I define "piracy" as the black market or extra-market duplication and circulation of otherwise commercially available media.

Comparative academic histories of "old" and "new" media have been prone to juxtaposing vinyl LPs and CDs or celluloid and streaming digital video while erasing "middle-aged" or residual magnetic tapes and cassettes from the evolutions of formats and practices.[3] Analog videotape was once a new technology, which has now become obsolete. By treating magnetic tape technologies as merely transi-

tional and inferior to what came before and after, such work presents a distorted and incomplete account, which ignores the material and experiential attributes of these recording and playback technologies—and the new modes and expectations of access that they introduced. I agree with arguments against seeing new media as revolutionary; rather, new media reveal continuities, collaborations, and periods of coexistence as technologies change. New technologies do not necessarily kill media when they upgrade the devices (Thorburn and Jenkins 1999, 1–16). What's new about new media are specific technologies, interfaces, and uses, but these technologies often rework pre-existing practices and concepts and live on as residual formats or as material clutter and e-waste.

## Ladies and Gentlemen: The Carpenters!

Haynes' *Superstar* (Fig. 7.1) is at once a portrait of a historical period and a critique of popular culture's failure to respond adequately to it. As performers whose image promoted conservative family values, *Superstar* positions the sunny Southern Californian Carpenters as something of an anomaly during a period of social revolt and political crisis. They were, however, an extraordinarily popular anomaly, who scored twenty Top 40 hits between their debut single "Close to You" in 1970 and anorexic Karen Carpenter's lethal heart attack following an overdose of Ipecac syrup in 1983.

In portraying Karen's life, Haynes presents the cultural context for the group's fame and her body issues. He simulates the Carpenters' domestic and professional dramas with a cast of Barbie-type dolls—and occasionally human body doubles and talking heads. In the process, the filmmaker structures the narrative through the generic modes of star biopics, disease-of-the-week TV movies, health educational films, and feminist documentaries. Haynes imitates and combines familiar film and television genres, not to critique these modes but to strategically use them to present allegorical narratives that function as shorthand for expressing the characters' emotional states and for producing audience affect. Haynes not only combines disparate narrative methodologies but also textures the film by interweaving a variety of media and aesthetic styles. His work in *Superstar* was influenced by the late-1970s/early-1980s shift from purely formalist experimental cinema to an avant-garde cinema of narrative experimentation used to explore social issues.[4] *Superstar*'s allegorical connections between Karen's anorexic wasting and the emaciating effects of AIDS would have been nearly unmissable at the time of the film's release. I suspect the more historically removed we get from the 1980s public panics over AIDS, the less the text will be received allegorically, and *Superstar* will be seen increasingly as "just" about eating disorders and media culture.

Figure 7.1: A screenshot from a bootleg copy of *Superstar: The Karen Carpenter Story*. The image reflects the visible distortion of VHS reproduction, including flagwaving and desaturation of color.

For those who have not seen *Superstar* or who do not have ready access to re-see it, I will begin with fairly detailed descriptions of a few early montage sequences to convey the film's complex structure. The film opens with a black-and-white point-of-view shot—"A Dramatization," as it is marked—that presents Karen's mother searching through a house and finding a dead body lying in the closet. The film then quickly changes tone, as a male narrator's authoritative voice raises rhetorical questions that promise to be answered, to make sense of the horror. Mundane images of suburban Californian homes drift across the screen as the fancy cursive credits appear and Karen Carpenter's disembodied voice sings the familiar, sad opening verses of "Superstar." Following the discovery of Karen's corpse, the song has a surprisingly chilling effect—until it shifts up-tempo for the chorus, when the sad love song inexplicably turns celebratory, drowning out the heartache scripted in the lyrics of youthful love and desperate hopes: "Don't you remember you told me you loved me, baby?" This song's shift in tone presents a dual affect of melancholy and feigned joviality; such emotional tensions and transitions appear throughout the film's shifts in genre and address, alternately conveyed with irony and sincere mourning. If the film can be read as camp, it is only in the way suggested by Richard Dyer's description of gay male audience attachments: "passion-with-irony" (1986, 155).

Although predominantly shot using dolls for actors, *Superstar's* framings, camera movements, and editing adhere to live-action modes. (The film was shot as live

action, rather than as stop-motion animation.) Comically, the establishing shot for the family home in Downey, CA is superimposed with the label "A simulation." The domestic and performance scenes are shot in the manner of Douglas Sirk's melodramas (prefiguring Haynes' *Far From Heaven*), with pans showing Karen framed in windows or in the background and with relatively few close-ups. When the Carpenters perform "We've Only Just Begun" for a television broadcast, the camera movements and cutting resemble the construction and décor of the period's TV variety show musical numbers. The sequence segues into a standard music montage, with various cutaways to different activities documenting the Carpenters' offstage lives, presented in hokey Super 8 rear projection; the illusion is ruptured percussively, however, by repeated shots of a human hand hitting "a lackadaisically brandished tambourine" (Hoberman 1987, 67). The film allows the audience to giggle early on at the dolls' stunt casting and jokey moments before becoming progressively more tragic.

Frequently, the film operates in dual registers, as in the parodic educational film-within-the-film about anorexia, which is laughably didactic yet conveys substantial information. Although presenting a pathology in factual medical terms, the construction of the sequence mocks pedantic documentary form: broken up as it is by overly awkward live-action shots of women on the street asking basic questions such as "What is anorexia nervosa?" and "Do they really think they look good like that?" Adding to the comic effect while reconnecting the pseudo-doc to the narrative's plastic world, doll arms substitute for human stand-ins to illustrate the "normal" arm (chubby baby doll arm) and the "anorexic" body (Barbie-type doll body). The following "Top of the World" sequence recasts the meaning of the first line, "Such a feeling's comin' over me," as a reference to anorexic euphoria. This montage begins with a graphic match, cutting from a turning globe to a turning disco ball, and Karen's world tour diet of salads, iced tea, and Ex-Lax become a routine, edited with a rhythmic series of shots of a bathroom scale dial turning to measure Karen's diminishing weight. The sequence ends with the Carpenter family watching a performance together on television. While Richard and the parents cheer the TV act, Karen complains, "I looked really fat." The film posits that her self-perception was being increasingly mediated by television broadcasts and music critics' barbs.

Much of the fuss over the film has emphasized the novelty and, with a sentiment of skepticism undone, effectiveness of the doll stars. The film was conceived as a test case of sorts to see whether inanimate dolls can generate spectator sympathy and identification. Ironically, that the viewer can empathize reflects Barbie cocreator Ruth Handler's original intentions: she recalled that the original doll's "face was deliberately designed to be blank, without a personality, so that the projection of the child's dream could be on Barbie's face" (quoted in Mandeville 1990, 12, cited in Rand 1995, 40).

The doll scenes, however, only comprise about two-thirds of the screen time, and the "acted" doll scenes with dialogue look stiff in comparison to sequences when the Carpenters' songs provide the primary soundtrack and inspiration for fluid montage sequences. As in melodrama (literally, drama-plus-music), the Carpenters' songs trigger the emotional cues throughout the film, and Karen Carpenter's authentic singing voice imbues the dolls with their much-acclaimed subjectivity. *Superstar* viewers may find themselves in the ambivalent position of singing along to songs they might otherwise be embarrassed to enjoy, as Coco Fusco observed in her self-reflexive review of the film:

> I was stunned by the realization that I and everyone else in the room knew every lyric by heart. Those sappy tunes had infected us all, just as much, if not more than, the Grateful Dead. And the extraordinary response to the film, which transformed the 27-year-old Haynes into an avant-garde superstar just weeks after the *Village Voice* proclaimed the death of avant-garde cinema, signals that the film hit an ever-vibrant pop-cultural nerve. (Fusco 1988, 18)

Without the melancholic sound of Karen Carpenter's sonorous voice and occasionally ironic literalizations of the lyrics, *Superstar* simply wouldn't work (for a recent account of Karen Carpenter's resonance, see Tongson 2019). Rather than relying solely upon the dolls' emotive capacity, the film's wit and its affective ability are attributable to its use of the Carpenters' music, formal and generic play, and, on video, the material degeneration of re-recorded tapes.

## For All I Know: A History of *Superstar*

Although writing on Haynes' oeuvre has alluded to the film's status as an underground classic and bootleg favorite, it had not previously attempted to account for its prevalence or the ways in which bootlegging has altered the text. *Superstar*'s reception has been influenced meaningfully by the conditions of its exhibition and circulation, even more so since its withdrawal from licit distribution. Therefore, it seems essential to revisit the film's history and perhaps correct some of the film's production and distribution lore prior to reading analog video copies' bootleg aesthetic (for a more detailed history, see Hilderbrand 2004, 61–70).

## Exhibition History

*Superstar* debuted at the downtown New York spaces Films Charas and Millennium in July 1987. In August the film screened again as part of Karen Carpenter Night at Pyramid, a gay-friendly postpunk nightclub on Avenue A, which was a hotspot for dancing and performance at the time.[5] In late 1987 and early 1988, the film continued to screen, on film or as a video installation, at various venues in the city. Beyond New York City, the film also had a vibrant life across the country, with extensive popular screenings in 1988 and 1989. It screened at the USA Film Festival in Dallas, where it won the National Short Film and Video Competition; San Francisco International Film Festival, where it won the Golden Gate Grand Prize for Short Narrative; the United States Film Festival (renamed Sundance a few years later); and Toronto International Film Festival. Concurrent with the film's festival events, it screened at museums, colleges, artist centers, and at rep houses as part of special events or midnight runs across the U.S.[6]

During the two years of the film's release, *Superstar* had already been integrated into the curriculum for college courses and was being used at eating disorder clinics as an educational and discussion aid, presumably screening on video. Additionally, there were tapes circulating among film industry folks, who would watch *Superstar* over lunch hours or at parties; preview tapes had gone out to the press and curators as well. Haynes also sold approximately sixty VHS copies of the film, complete with homemade covers and transcriptions of the difficult-to-read intertitles within the film, through a bookstore in Los Angeles, and bootlegs were already available in alternative video stores across the country. Thus, legitimate and bootleg tapes already began circulating simultaneously with the film's theatrical and gallery screenings.

The public screenings and private viewings recounted here, though falling short of comprehensive and ultimately impossible to document exhaustively, demonstrate the film's extensive screenings across the country. In addition, the range of venues and presentation modes suggest the varied ways it was positioned for audiences: as an avant-garde art film, as a party musical, as a fan text, as a video artwork, as a midnight cult flick, as a festival indie, as a museum piece, as a pedagogical tool, as a therapeutic text, and as a collector's item. These multiple identities and modes of address may in part suggest the film's appeal to varied audiences and demonstrate the film's complexity.

## Legal Problems

If the film's gimmick of using dolls for actors helped make it infamous, its withdrawal from official distribution due to legal trouble has made it legendary. Significantly, Haynes was conscious during production that his film might court unwanted advances—from both the Carpenters and Mattel. Coscreenwriter and co-

producer Cynthia Schneider, now a lawyer, was beginning her foray in the legal field during production and was conscious that the film could avoid allegations of libel by only portraying biographical details that had previously appeared in print. Late in the production of the film, Haynes also attempted to secure the rights to the Carpenters' music by sending letters to the various music publishers. "Top of the World," cowritten by Richard Carpenter, was among Haynes' requested tracks and figured prominently in the film. (All the other songs were written by other composers.) Haynes received an immediate response from Richard Carpenter's representative asking for more information, and he replied with a synopsis and personalized statement of intention, expressing that the film was sympathetic to Karen Carpenter and explaining that it was a student film that would not be screened for commercial purposes.[7] Two months later Richard Carpenter's representative replied that Haynes could not make the film, use the songs, or portray any biographical information. By that point, *Superstar* was in late postproduction, and Haynes decided to complete the film anyway. Soon the film began to screen publicly, but for the next couple of years, Haynes did not hear back from Richard Carpenter's representatives—or other music publishers or record company officials.

Mattel, the manufacturer and owner of Barbie, her pals, her products, and her trademarked identity, first took notice of the film in 1988 but never pursued fully-fledged legal action or sought damages against the film.[8] *Superstar*'s legal problems officially started in October 1989, when Haynes received three cease and desist letters: one from Richard Carpenter's music publisher (Almo Music Corp./Hammer and Nails Music, Inc. ASCAP), one from the Carpenters' label (A&M Records), and one from the Karen Carpenter Estate. These letters and subsequent correspondence charged that *Superstar* violated copyright laws through unauthorized use of the Carpenters' music, logo, likenesses, and life story.[9] The complaint against the film was never phrased in terms of the artist's or record company's revenue losses. If anything, *Superstar*'s popularity increased sales of the Carpenters' albums and functioned as an incredibly effective promotional vehicle for the by then unfashionable duo. Significantly, Haynes was not asked to pay any damages for copyright infringement; instead, the legal correspondence demanded that the film be completely removed from circulation. Richard Carpenter did allow for one major concession, seeming to understand a young artist's need to build and promote a career: Haynes could show the film to critics in relation to his other work. Since 1989, Haynes and his lawyers have made a couple of efforts to clear the ban on the film so that it can be released again; clearing the music rights remains the necessary precondition for its reemergence.

## Back in Circulation

For a film that has been removed from official distribution and has been historically difficult to access, *Superstar* has had an astonishing, irrepressible afterlife. Although its primary mode of circulation between late 1989 and the mid-2000s was through an informal underground network of shared bootleg videotapes, *Superstar* continues to be seen in large-audience (if not always exactly *public*) settings. University classrooms continue to rank among the most prevalent venues for illicit—if educational—screenings. I've heard of a screening in, curiously enough, an "intro to video" class; it has also been taught in classes on narrative structures, alternative cinemas, film theory, feminism, American popular culture, documentary theory, and introduction to art. One friend first learned of the film when it showed in the first weeks of his brother's freshman-level intro to film class for production students, apparently screening early in the semester as both an eye-opener for youths who had never seen anything like it and as a model for what low-budget filmmakers could accomplish. Other friends have recalled seeing the film in the early 1990s in informal settings, from a Dallas nightclub to a party in a rented Los Angeles storefront to a Washington, D.C., cult film club's monthly bar night, to a meeting of the Sao Paolo Carpenters Fan Club, to a television broadcast in Amsterdam. In the mid-1990s, it is rumored to have screened at film festivals and micro-cinemas in Baltimore, Ann Arbor, and San Francisco and a major art museum in New York City. Since 2000, museums, micro-cinemas, theaters, and festivals from coast to coast (and to some extent overseas) have also repeatedly made this "surprise," "secret," "early" Haynes "short" available for public consumption—in rare cases on 16 mm and making a point to publicize that fact. *Superstar* typically screens within the context of the filmmaker's other work or within doll-themed programs and is either shown unannounced or promoted through keywords (in quotation marks above) for in-the-know audiences. Other public events have explicitly lauded the work's illicit status for the counterculture kids, advertising the film by title and assuredly showing bootlegged videos.

The drive to show and share the film must be worth the gamble for venues—a testament to programmers' and audiences' love for it. To my mind, the most telling promotional text for a *Superstar* screening appeared in the calendar listing for a 1998 event at the Blinding Light Cinema in Vancouver, where it screened repeatedly: "Though we swore we'd never show it again . . . due to overwhelming public demand we are pleased to present this long-banned underground classic. . . . [T]he mediocre quality dub which you [will] see here, [is] viewed with a certain charm and respect rarely given to degraded video."[10]

## Grainy Days and Mondays: Theorizing Bootleg Aesthetics

As the Vancouver screening advertisement mentions, the bootleg tapes of *Superstar* typically reveal lost resolution from multiple generations of duplication, so that the color looks washed-out and the audio sounds distorted. The typical transfer format—NTSC VHS—ranks among the lowest-fidelity commercial tape stocks, and VHS-to-VHS dubs reveal steep resolution loss from generation to generation. This residue places the *Superstar* bootlegging phenomenon within a specific technological moment: it was only possible after personal VCRs were pervasive, but the generational deterioration specific to analog recording predates digital video reproduction. (Digitized copies clone data but may have reduced resolution due to compression.)

Since the film went underground, the isolated hush-hush and self-consciously transgressive 16 mm screenings offer film purists opportunities to see the work in more pristine condition. I would suggest that the proliferation of degenerated copies of *Superstar* contributes to the allure of an idealized filmic original. The same might be said for home video generally, which prompted a comparative valorization of seeing classic films in restored prints on the big screen. When I saw *Superstar* projected on 16 mm, the auditorium was packed with people who had seen and likely owned copies but probably had never seen the film "in the flesh." As a low-budget film shot over the course of a couple of weekends, even in its original format, *Superstar*'s titles are still nearly illegible, the film generally grainy, and the sound still rough. Seeing the film on film made me nostalgic for my warped dub at home. For me, part of the experience was missing.

At the risk of getting all poststructural, video reproduction calls into question the very notion of an "original" film. Yet, at the same time that degeneration helps to invent the categories of originality or fidelity in reverse, I suggest that it also creates new, personal, and arguably technologically specific meanings. Analog duplication of the text, rather than destroying the original's aura, creates a new kind of aura that references the indexicality of analog reproduction and sensuously suggests the personal interventions that made the copy possible. Materially, the fallout of the image and soundtrack marks each successive copy as an illicit object, a forbidden pleasure that has been watched and shared and loved to exhaustion. Furthermore, the de-resolution of the tapes formally reflects the story of Karen's wasting away. The film's theme becomes expressed on the surface, even as it frustrates and interferes with standard spectatorial engagement with the narrative as the visual and audio information become obscured.

Significantly, Haynes not only appropriated music for his film but also repurposed television footage. Taped from television with a VCR and then played back and reshot in 16 mm from the surface of a monitor, these images appear with the film camera's flicker out of sync with the televisual pixel scanning, so that the im-

ages are distressed by black lines rolling vertically across the screen as well as loss from reproduction between formats. Although Haynes worked to minimize the deterioration effect during production, a trace of the format mismatch remains and contributes to the film's expressive effect.

Haynes uses found footage as television transmissions and media-effected memory in *Superstar*. TV monitors appear within the miniature *mise-en-scènes* throughout the film, and footage is intercut to rupture the diegesis of the doll scenes. Although the references are identifiable in the distressed footage of President Nixon, the American troops in Vietnam and Cambodia, the protests on the domestic front, and moments from *The Poseidon Adventure* (1972), *The Brady Bunch* (1969–1974) and *The Partridge Family* (1970–1974), they do not necessarily refer to specific speeches, moments of war, or episodes of sitcoms but to a general cultural memory of the time. Here Haynes' appropriations function less as recontextualizations or subversions of corporate media than as a historicizing method to present the cultural context for the Carpenters' anachronistically wholesome star personas and music that "led a raucous nation smoothly into the '70s." But this purported "smoothness" jars with the rough-textured television-to-film(-to-bootleg video) footage, emphasizing a disjuncture between Karen Carpenter's soothing voice and the controversies documented and remembered.

## Bootleg Aesthetics

My research on videotape began in response to a seeming lacuna in relation to the aesthetics of analog video and the ways in which bootlegging can be read as a cinephilic practice. Relatively little had been written describing the effect of decay and reconfiguration that occurs when video is reshot on film—or when it is then repeatedly recorded from video to video. I suggest that each videotape duplication can be understood as having a unique effect on the transfer and that each cassette becomes a singular text that contains and compounds its own history. The distress and disappearance of the video signal, which cause tracking problems for far-from-heavenly VHS tapes, call attention to the tapes as copies—analog, personal copies. These blurry bootlegs foreground duplication and remind viewers that they are indulging in a pleasurably transgressive viewing act.

Significantly, there are depreciable distinctions between *Superstar*'s internal image appropriation and the audience's video bootlegging of the film. The effects of Haynes' nonsynchronous TV-to-film recording differ from cultist video-to-video reproduction: sharp pixelation, scrambled signals, and visible rolling black lines are clearly present in Haynes' appropriation, whereas the video dubbing makes the image less focused and washes out the color intensity. Viewers of the bootlegs engage with the text on a format-specific basis, knowing from the film's first moments (if not from word of mouth even earlier) that they are watching a self-reflexive collage

of images that have been further decayed through wear and reproduction. But, to trot out an oft-cited Roland Barthes argument, video reproduction of the text materially records the audience's (reader's) use and abuse of the text, rendering the "death of the author." Haynes is quite likely the most theoretically influenced and self-conscious contemporary American *auteur*, but Barthes' paradigm-shattering argument that readers produce textual meanings, not authors or critics (1977, 146), is helpful in articulating the role audiences play in recreating and redistributing *Superstar* and the differences between the internal and external distressed image effects. Haynes' unauthorized star study effectively becomes un-author-ized through video re-production. To phrase the issue in Barthes' terms, Haynes' use of found footage *expresses* both Karen's psychological state and Haynes' media critiques, whereas the video-to-video bootlegging *inscribes* the histories of the videos' circulation.

Haynes' expressions are not erased by bootleg inscriptions; rather, the effect is one of mediation as the compound filtering of multiple-generation bootlegs alters the viewing experience. Watching a bootleg presents a constant negotiation of one's own perceptual attention; the viewer must choose to focus on the distortion or attempt to peer *through* it to see Haynes' original intended images and must fill in the muffled pop tunes from memory while listening closely to filter through the garbled dialogue. Of course, seeing and listening more generally are also learned processes of filtering sensory stimulation, and watching a film or video entails actively not seeing: by directing our attention to the screen, by ignoring audience noise, and by relying upon the innate perceptual slowness that allows for the persistence of vision (on vision and blindness, see Elkins 1996, 201–202; on listening and "audile technique," see Sterne 2003, 112–113). Likewise, there are all kinds of auditory phenomena and sound effects that are beyond the standard range of human hearing or attention but that nonetheless contribute to the soundtrack.

Precisely because analog video interference forces the audience to focus and filter perceptual attention, I suggest that watching distressed tapes of *Superstar* presents a model of spectatorship perhaps more illustrative of semiotician and psychoanalytic film theorist Christian Metz's formulation of cinematic identification than classical Hollywood cinema (although the ideological effects certainly differ). The video viewer becomes more aware of the format through its distortion, and thereby primary identification *is* with the viewer's own gaze as Metz suggested, while anthropomorphic identification with the dolls must be secondary (1982, 45–49).

Though Metz was attempting to move beyond the phenomenology of classical film theory (1982, 52), phenomenologist Laura Marks engages Metz's model. Marks (2002) acknowledges the erotics of image deterioration, whether due to age, wear, or artistic intervention. Marks proposes that cinematic identification is grounded in a bodily relationship to the screen and that films and videos that

present hard-to-see, deteriorating, or pixelated images offer a haptic, melancholic empathy. But rather than presenting death as horrible, these mortified images offer the viewer new, tangible, intimate, and frequently beautiful relationships to material loss (Marks 2002, 97).

As I will argue in the next section, subjectivity is produced additionally through relationships to the videocassettes themselves. The intersections of materiality and affect can best be articulated through the concept of the fetish. Fetishism—in religious, Marxist, Freudian, and vernacular conceptions—describes the associative values invested in objects that transcend their forms as objects. In the late 1980s and 1990s, cultural scholars and historians turned to fetishism as a new methodology (on fetishism, see Pietz 1993, 119–151; Stallybrass 1998, 183–207). Bootlegged tapes of *Superstar* multiply function as fetishes: as precious objects, as the products of reproductive labor, as substitutes for absent film prints or commercially produced videos (not to mention Karen Carpenter herself), and as souvenirs of the fans who have made them. Perhaps appropriately for *Superstar*, plastic cassettes of the film, like dolls, are often anthropomorphized and imbued with sentimental meanings. And like Karen Carpenter, VHS has been hugely popular but rarely given its due praise or deemed worthy of aesthetic analysis.

## (They Long to Be) Close to *Superstar*: Reception Studies

*Superstar*'s unplanned bootleg circulation presents a democratization of distribution at the same time as it makes access elitist; seeing or obtaining *Superstar* in the analog era—before it became available through eBay, file-sharing networks, or free streaming sites—depended upon insider connections or serendipity. In addition to conceptual connections I have suggested between the anorexic narrative and formal degeneration, the wear and fall-out of tapes present material evidence of fan use, duplication, and dissemination—marking an otherwise impossible to retrace and unwritten history of circulation.

Whereas the footage Haynes reshot and inserted works (in part) to locate the story within a specific historical setting, the defocusing and the paling effect of video duplication suggest the tapes' geographic and temporal dispersion. The uncontainable and in many ways untraceable exchange of tapes produces a proliferation of meanings, responses, and personal engagements with the text. I like to think of the exponential duplicating and distribution of bootleg tapes as akin to scattering Karen Carpenter's ashes—not tossed to the wind or into the ocean but into the collections of fans and cinephiles. And, of course, there is the alternate perspective that bootleg circulation keeps the film and Karen Carpenter alive.

In the case of *Superstar*, bootlegging's resonance for viewers cannot be limited to playback aesthetics. In initially researching the film's and tapes' ephemeral circula-

tion, I sent out an informal mass email inquiry to friends and colleagues I assumed had seen it, asking where they had first seen it and if they had acquired their own copies. Later I posted similar surveys on relevant listservs. Here and in my project more generally, the anecdotal and the colloquial serve to suggest the personal and the everyday relationships and experiences users have with videotape.

I received numerous responses, especially from acquaintances and strangers, that detailed the specifics of their personal experiences. These anecdotes revealed a spectrum of encounters and collection policies, all of which ultimately demonstrated considerable personal attachment to the text. I received stories about illicit means of accessing personal copies, such as secretly duplicating a tape borrowed from a professor, stealing a tape from a boss, and nearly stealing the tape from a roommate. One person claimed that his source had been taped off-air from Japanese television. Some tracked down copies at specific alternative video stores, swap meets, or fan conventions. Most friends told all, while a few were adamant that their *Superstar* suppliers "remain nameless." Some attempted to account for the degrees of separation between their copy and the filmmaker—and, by extension, there were frequent speculations about what duplication generation their tapes were (third generation seems to be a popular if unlikely estimate). I was told personal preservation strategies, such as supervising all screenings to avoid having a loaned tape lost and, impressively, remastering a bootleg onto the sturdier Betacam SP format. A few reported that old bootlegs had worn out from use and loaning and that they had tracked down replacement copies. A couple of people even reported having watched the tape on first dates; the lure of seeing the rare film apparently functions as a viable seduction technique. Friends replying that they hadn't seen the film expressed a desire to do so—rather, something close to insistence that I show it to them—or, in one case, embarrassment about not being able to claim the cachet of having seen it.

What all these anecdotes suggest is the multiplicity of personal meanings and sentimental values these tapes represent for their collectors. Although in most cases the root motivation for obtaining copies simply derives from wanting to see an obscure film or to possess a favorite text, *Superstar*'s out-of-distribution status complicates the tapes' value. The film's relative scarcity increases its worth and drives viewers to reproduce it when they finally have access to it; these actions suggest fear that they may not have access to it again and dedication to maintaining their personal access. Because of the tapes' scarcity, higher-resolution dupes—those fewer generations removed from a master and displaying less distortion—become longed-for objects. The bootlegging phenomenon, in effect, created an amateur strategy to preserve the work and keep it in semipublic circulation through a wily and ultimately uncontainable network of tape sharing. Obviously, no accurate census of *Superstar* dupes will ever be possible, as they have circulated

and been reproduced, though the epidemic testifies to the grassroots potential of home taping.

While acknowledging that video collectors are motivated by a text's rarity or, conversely, sudden availability, Charles Tashiro has suggested that video collecting is predominantly based upon irrational "'emotional' reasons." He creates a hierarchy between acquisitions that are liked and those that are loved; liked ones are frequently viewed on tape—a format that inevitably wears out—while loved ones (or those that one should love and own) are often promoted to digital disc formats that sit upon the shelf in pristine, unused condition (Tashiro 1996, 12; see also Bjarkman 2004, 217–246). The like/love contradiction is also legible in bootleg proprietorship: the like impulse prompts the fan to watch and share the text as much as possible, whereas the love impulse makes preservation the priority. In the latter, there is a fear of watching the text too much—and thereby risking physical wear and emotional inoculation, corporeally damaging the cassette, or getting bored by it. A video collection and its usage thereby reveal its owner's personality on the shelf. Indeed, as Baudrillard states, "For it is invariably *oneself* that one collects" (1994, 12).

My first email survey to friends basically confirmed my assumptions about the economics of the bootlegs' circulation, but what really struck me about the replies was that in every case, the respondents recalled the exact sources and circumstances of obtaining their copies. Even if they didn't remember precise dates, they expressed that they remembered who gave them the tapes, what their relationships were, and frequently specified whether they were connected through school, work, friends, relatives, or auction. Each individual cassette has been invested with a sentimental personal association or a quest narrative, such that it not only safeguards its owner's access to a favorite text but also records a personal history. A particularly affecting response came from Jim Hubbard, whose copy is quite literally a *memento mori*:

> I have a VHS copy (more a copy of a copy of a copy of Dior) that I inherited from a writer friend who died in November 1994. . . . To me it's more important as an object that belonged to my friend Dave than as Todd's film (which is rather poorly represented by this copy).[11]

Such sentimental value often does not transfer to extended users, however. Usually, whenever a friend would ask to borrow a copy of *Superstar*, they asked for my *best* copy. While this may contradict my claims for bootleg aesthetics' associative value, it does emphasize general recognition of the degenerative materiality of videotape and the specificity of personal attachments.

Bootleg tapes exist as souvenirs of specific periods in their collectors' lives, intimate and professional relationships, and searches for elusive objects (on souvenirs, see Stewart 1993; Olalquiaga 2002). By virtue of its underground, bootleg-based

circulation, *Superstar* in its analog era had primarily and significantly been available through *personal* connections. The tapes, then, not only present an emotional narrative dependent upon the viewers' nostalgic associations with the Carpenters' music and the "naïve" early-1970s pop culture but also evoke memories of the tapes' sources.

After two decades of underground life, *Superstar* cannot be discussed outside of the context of its distribution. Nor, I argue, can it be analyzed without looking at the meanings encoded onto the dub tapes. As a film in which the surface expresses the emotional and physical states of its main character as well as its political critique, it is perhaps fortuitous that it has become accessible primarily in low-fidelity dubs. Bootleg aesthetics visually and acoustically replicate the psychological and physical trauma experienced by Karen in the story; these warbled tapes also record the cult audience's participation in remaking the text with each new duplicate produced and circulated. One of the great ironies of bootlegging is that it preserves *Superstar* in the public's possession as it progressively destroys the original work. Analog reproduction repeatedly renders the collective demise of the narrative subject, the author, and the format. Karen and Todd, we love you to death.

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## Notes

1 An early version of this chapter was first published in *Camera Obscura*, no. 57 (2004). This chapter has been condensed and reprinted from the revised version published in "Introduction: The Aesthetics of Access," in *Inherent Vice*, Lucas Hilderbrand, pp. 1–32 and "Grainy Days and Mondays: *Superstar* and Bootleg Aesthetics," in *Inherent Vice*, Lucas Hilderbrand, pp. 161–190. Copyright, 2009, Duke University Press. All rights reserved. Republished by permission of the copyright holder. www.dukeupress.edu

2 After developing this argument through this manuscript, I belatedly discovered a similar argument in Ernst (2002, 625–637).

3 I conceived and wrote this work in the wake of such comparative histories of "new media"; video studies and infrastructure studies have emerged as important fields in media studies since that time (see, for instance, on video Klinger 2010, 106–124; Benson-Allott 2013; Herbert 2014; Newman 2014; Neves and Sarkar 2017, and, on infrastructures, Larkin 2008; Lobato 2012; Gillespie, Boczkowski, and Foot 2014, Parks and Starosielski 2015).

4 Haynes refers to Sally Potter's *Thriller* (1979) as a particular influence. Haynes, telephone interview with author, August 12, 2003.

5 Haynes, press release, July 1987.

6 Exhibition history reconstructed from the interview with Haynes, as well as reviews and listings in relevant publications and email survey responses.

7 Haynes started the film while in an MFA program at Bard College.

8 Both previously published versions of this chapter give a more detailed account of the film's legal history and of Barbie's cultural resonance.

9 Notably, the published screenplay includes reprint permission notices for lyrics to all of the Carpenters' songs in the film except the Richard Carpenter-composed "Top of the World." Todd Haynes, *Three Screenplays* (New York: Grove Press, 2003), n.p.

10 Source: http://www.blindinglight.com/prog.asp (June 7, 2003). The venue closed in July 2003.

11 Hubbard, email correspondence, September 8, 2003.

# 8. What Makes a Download a Stream?

*Frank Bauer and Philipp Kurth*

## Introduction

There is a vibrant discussion about streaming, data transport through the cloud and various compression technologies for audiovisual media. However, there is one startling detail missing in the debate: when is a download a stream, and why do container formats matter? At first glance, this might seem like a strange comparison because it seems obvious: streamed media is found above all on Netflix and other streaming platforms, while video downloads are familiar from private video sharing, stock media sites (like Shutterstock) or illegal portals. Nevertheless, the truth is more differentiated. Moreover, the term download is a complicating factor. When we use the term streaming, we are usually referring to networked streaming, for example, over the internet. Yet it is worth taking into account the entire lifetime of a video from its inception (e.g., when captured by a camera) to its end user delivery. In particular, it is notable that video data is streamed from the very beginning, before any networks get involved. When a camera sensor records the image data, information is continuously streamed over an internal bus to the video encoder hardware and the storage device. The resulting file is not generally in the optimal format for either download or network stream, and will thus be converted into an appropriate format. In this article, we will illustrate the fundamental technical aspects of video compression and the role that container formats play. We will use the latter to argue how the structure of the file can hint towards the intended use, i.e., when a downloaded file can be regarded as a streaming medium. However, first we need to define the meaning of "download" for this text.

## By Definition a Download

We define a download in the context of a network connection. Downloading is the process of receiving data from a remote machine. The opposite is an upload, whereby the data is sent to a remote machine. We will often call the remote machine

a Server or a Host (as the machine is hosting the data we want to download) and the receiving machine a Client.

Since typical streaming media are not stored on a local machine but on a remote system (like the Netflix servers, or more precisely a Content Distribution Network (CDN) that distributes the content for Netflix), it is by definition a download. Streaming is often deemed a particular form of download. The differentiating factor commonly used is the volatility of the data on the consumer's machine. A downloaded file is permanent, while the data sent during streaming is transient and automatically deleted as soon as it has been consumed or the playback stopped.

The distinction is also often cited in legal arguments, as either download or stream has very different implications on liability in Europe. One long-standing interpretation is this: consider an illegally published video file. If a user accidentally downloaded the file, that user would be liable for downloading it. If a viewer accidentally streamed that same file, the person hosting the content would be accountable for any infringement. This distinction was made in a particularly dicey German case, where thousands of internet users were sent a cease and desist letter with fine for allegedly downloading illegally published pornographic content (Solmecke 2013). The sending law firm classified the consumed media as downloads, while defenses often argued it was streaming. Some declared that it was a progressive download (middle ground between a download and a stream), whereby you can watch the content while it is being loaded. During the download, the data is temporarily stored in the browser's cache,[1] where it will remain even when playback has finished. Caches are cleared eventually, and, on iOS or Android, they are not even accessible to the user. Nonetheless, the fact that the media remained on the user's machine even after the playback had ended caused some legal representatives to classify this behavior as downloading and not streaming. Details like this complicate the arguments and require in-depth technical knowledge to find appropriate rulings in court. It is important to note that the judgment of the courts differs widely on the interpretation of Article 5 of the EU-Directive 2001/29/EC concerning streaming media (Hugenholtz 2018).

Hence, applying this volatile definition of streaming is dangerous. As we have described, most modern browsers allow users to watch downloadable media while the download advances, in some cases even without storing the files in the users' download folder, but instead in temporary, internal locations that (depending on browser settings) will be erased once the session is closed. In contrast to a stream, such progressive downloads are not customizable (i.e., in language or quality selection) and deliver the exact same content to all users.

Some tools can convert streaming media (for example, from YouTube) and assemble it into a working, local video file. When considering this aspect, we could argue that the classification of download versus stream is not an inherent property of the distributed data but something that depends on the tools a consumer uses.

This assumption renders a label like "streaming platform" invalid, as the platform (the remote site hosting the video data) can never determine whether the delivered files are a stream or a download.

There is a more straightforward way to distinguish streaming media from downloadable content, which is based solely on the published data. This approach could help to overcome the ambiguities of the previously introduced definitions. To apply it, we need to understand networked streaming and dig into the depths of codecs and containers.

## Codecs and Containers—A Primer

In our experience, many people confuse a video codec with the container format. However, the two serve different purposes. The video codec determines the way content is compressed, while the container determines the arrangement of that compressed data, for instance within a file. This distinction is essential for our discussion. We want to attribute the label streaming or download based on the properties of a file. As we will see, the decision is mostly informed by the container format used and not the codec.

A video (compression) codec is something like Motion-Jpeg (MJPG), MPEG-2, H.264, H.265 (also called HEVC), the upcoming H.266 (also called VVC), ProRes, RedCode or ARRIRAW. MPEG-2 and the H.26x-series are continuous improvements of the same principle of compression focused on end-user consumption. ProRes, RedCode and ARRIRAW are compressions for a different kind of market and mainly target the production cycle of a video. Compression is an essential aspect of networked video. Generally, the amount of data for a video is enormous. A single frame of uncompressed 4K, UHD (3840 x 2160 pixels, 10-Bit color depth per channel, no chroma subsampling, no audio) video amounts to about 60 MB in storage. A 90-minute movie (without sound) would result in a 5 TB file. For comparison, a Blu-ray can store up to 50 GB (=0.05 TB), which includes audio as well. This amount of data is not playable in real-time over a typical consumer network. With a fast 1000 MBit/s network, the download of that video would take about 10 hours to transfer. However, the average bandwidth is lower, especially on mobile networks, where a vast amount of video is consumed. According to Fenwick and Khatri (2020), the average German download bandwidth in 2020 on a mobile connection was only 30 MBit/s, increasing the download time to about 15 days. In that same report, the users gave Germany a video experience score of 74 out of 100 points. That disconnect (an average download time of 15 days versus four-star satisfaction) underlines the importance of compression for practical use of video data and is the necessary foundation for the rise of YouTube, Netflix and other streaming service providers.

Still, why do we need containers? Container formats combine and arrange the compressed video data with audio, subtitles and other information. Without containers, we would not be able to consume compressed video at all. Well known representatives are QuickTime (.mov), Matroska (.mkv) (Matroska 2020), Audio Video Interleave (.avi) or the creatively named MPEG-4 Part 14, better recognized as mp4.

A video encoder will usually convert the video from an input format into the desired output. Since most video compression is not lossless, this step will negatively impact the quality of the video. Non-professional users often apply this recompression without need, due to the confusion between container and codec. For example, a video is stored in a Matroska format, but the editing software cannot import it. Users will then use tools like FFmpeg or Handbrake to convert the video into a supported format, let us assume QuickTime. Default settings of that tool will recompress the video and store it in the new container. Though, if the video was initially compressed with H.264, for instance, the recompression was unnecessary, as both containers (Matroska and QuickTime) support H.264 compressed video. The right conversion is re-muxing, basically repackaging the video data from Matroska to QuickTime, as this would not change the video quality.

It is crucial to know that containers and codecs have a symbiotic relationship. A regular video codec applies some kind of compression scheme to the frames of a video. Typically, the output of a codec is self-sustained, sequential packages of frame data (not an entire video). But the compressed video data generated by a codec is useless without a container. Container formats, on the other hand, know how codecs generate packages and can use that information to structure the data within a file. This fact allows us to change the container format (which is just a management data structure) without recompressing the video (which would change the codec, triggering a recompression and degrading quality).

## The Principles of Networked Streaming

As we have seen, it is a challenge to find a good definition of a download. Since we aim to distinguish it from a stream, it is instructive to take a close look first at a typical streaming experience, as well as the technical challenges that are handled by the streaming service to provide it. We have chosen one that is probably most familiar—end user streaming.

### The User's Perspective

Consider a consumer streaming their favorite show over a streaming platform such as Netflix, HBO or Amazon Prime Video. Users, in general, have different ways at their disposal to consume the content offered. They can choose between a browser,

desktop or mobile app to watch the content. For the sake of this example, we will assume a mobile app on an iPhone 6s[2] will play the video.

1. The user selects an episode that has been partly watched on the desktop app before.
2. After a brief moment, the playback resumes at the last watched point, with the previously selected language and subtitle settings.
3. Because the viewer had slept through the last minutes, they rewind the video to catch up. Shortly after, the playback resumes from the rewound position.
4. A couple of seconds later, the video and audio automatically adopt a higher definition.
5. As that episode finishes, the next episode starts.
6. The user chooses to skip the show's intro scene, causing the video to jump forward.

## Behind the Scenes

At the backend, the place that will deliver the content to the viewer, the same interaction looks like this.

1. An authenticated user of the service sends a request to continue the last played episode of a show. Querying the database for the user and the selected content reveals the last frame that was played by the consumer's device. The returned information also includes the playback application and device, as well as language and subtitle preferences. The last video was delivered with 5.1 sound as 4K UHD content compressed with H.265. However, the current request originates from a mobile app installed on an iPhone 6s. That hardware contains specialized decoder hardware for H.264 video only. While the quality and size of H.265 would be better, the energy profile of the app is worse, resulting in higher battery drain and less playback time. For this reason, the server will select an H.264 format for delivery. A similar choice is made for the audio content, as a 5.1 signal often wastes capacity. Consequently, stereo audio is selected. Since there is no information on the currently available bandwidth[3] for the mobile device, an average quality setting is applied.
2. The server assembles all the data needed with the correct quality and starts to send it to the client for playback. The system anticipates the next frame that will be requested by the player and preloads the data into a temporary cache. During playback, the client app continuously requests the next frames for playback. Those are delivered and deleted from the server cache. This deletion, in turn, triggers the preload of the next frames, and so on.

3. After a while, the client app requests an older frame that was not anticipated. The system clears the cache, reads the requested data from disc and sends it to the client.
4. Server and player app both monitor the time it takes for the data to arrive at the client side. As it is evident that the bandwidth can handle a higher quality stream, the currently loaded frame data in the server's cache is replaced with a higher quality version of the same moment in the video. From this point forward, all frames are delivered with the higher quality settings.
5. Later, the last frames of the video are delivered to the application. The system will also send a notification with those frames suggesting the following auto-played content to the player application. At the same time, the playback data for that video is preloaded and stored into the system cache. A short while later, the player requests the suggested content, which is met with the delivery of the cached data. Since a new episode has started, the system sends a notification that informs the player of the end position of the show's intro sequence.
6. Another brief moment later, that playback position is requested by the player. This forward seek forces the system to clear the cache, load the corresponding data for delivery, and continue the delivery from there.

## Is It a Stream?

We have called this chapter "The principles of networked streaming," which implies that we have described a stream and not a download. But why is that? We think this example represents the prototypical streaming experience and exposes two features that are unique to streaming:

- The ability to move through the video and start at an arbitrary position without any discernible delay.
- The ability to adjust the quality (and content, like the audio language) on the fly.

The first ability in particular may be surprising, as a downloaded file can be started and repositioned to arbitrary locations within the video, too. The difference is that this feature can only be offered once the download file is fully transferred over the network. When played directly over a network, playback can often only start at the very beginning of the download file or after a significant portion of the file has been transferred. The source location of the file is an important distinction. In this paper, we assume that the files reside on a network and not a local disc.

The second property, arbitrary quality selection, is more prominent. A downloadable file usually provides a single video stored in a defined codec (like H.265)

and quality. If it is at all possible to influence the codec or quality, the selection will take place at download time by choosing different files. Potentially, this constraint has some negative consequences when buying content on one device and consuming it on another. Let us assume the purchase was completed on a Desktop PC. The storefront that sells the video determines that the best format is a maximum quality video encoded with H.265 and sends the corresponding download link to the customer. When that customer chooses to use the iPhone 6s mentioned above for playback, the codec will waste battery life as it is not hardware accelerated.

This effect is also very prominent for older home-made videos in a user's library or older content from portals like Instagram, YouTube or Twitch. When the videos were new, the device (for example an iPhone 6s) or the video provider stored the content in the most efficient way, in that case H.264 compressed. However, later, when new hardware and codecs arrive, the same file is no longer optimized. In that case, playing it back on new hardware (that has H.265 acceleration but not H.264) can negatively affect the battery life. While current generation hardware still has a H.264 decoder along with new hardware for H.265, it is mostly just a matter of time until that outdated part of the hardware is removed.

While obsolescence is a problem on streaming platforms as well, they are better equipped to handle the initial example, whereby the content is bought and consumed on different hardware. A streaming platform can deliver a different, adaptive version of the same content. Both users and the service provider can thus adjust the playback quality to the capabilities of the hardware or the available network capacity. In 2020, during the Corona Crisis, many of Europe's employees worked from home and saturated the internet bandwidth with teleconferences, another form of live video streaming. During this time, Netflix, YouTube, Amazon and most other large streaming providers reduced the maximum quality of the content delivered for streaming (BBC 2020). It was possible to implement this change in a short amount of time because of the existing infrastructure for adaptive streaming quality. Providers simply did not offer higher bandwidth versions of their content. Without this prerequisite, all videos would have had to be recompressed in order to lower the consumed bandwidth.

This adaptivity requires a streaming platform to store multiple versions of the same video. But how does the server switch that video (and audio) mid-stream? Moreover, we have seen that the server does not deliver the entire file, but seems to have packages at its disposal that get transferred sequentially. To explain, we need to take a look at the inner workings of a container.

## Container or File Formats

As we have mentioned briefly, there are different compression algorithms (also called video codecs) for video data like MPEG-2, H.264, H.265 or H.266. Please note that these only apply to video, not to subtitles, audio or other metadata tracks. An encoder compresses the video into a bitstream representing the final data. However, there is no H.264 file format. That video bitstream is generally stored in a container format (typically mp4).

Most compressed or aggregated files rely on containers. TIFF, for example, is a container format for image data. It supports various compression algorithms such as Deflate, LZW or even JPEG.[4] The TIFF container specifies the compression format and some metadata about the image (i.e. size or bit depth) as well as the compressed data. We call TIFF a container as it supports a variety of compressions and multiple images within the same file, such as a preview image, compressed with JPEG, and the actual raw data using LZW compression.

Another widely used container format is ZIP. The files stored inside a .zip file are compressed with an algorithm—typically Deflate (Deutsch 1996; for available methods see pkware 2012). The container additionally stores the file metadata (like names, size, type), the file hierarchy (or folder structure), and the applied compression method.

## Tracks

Like ZIP or TIFF, video containers combine several different types of data (often attributed the term tracks or streams) in one file. Commonly, these are the video track and one or more audio tracks, as well as subtitles and control or metadata tracks. Before we come back to our base observation (download versus stream), we will take a brief look at the different track types usually present within a container (see Fig. 8.3 for a sample of tracks stored for a typical consumer video).

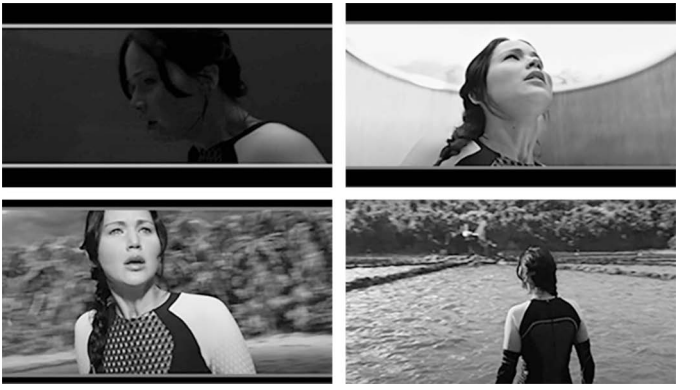


Figure 8.1: *The Hunger Games: Catching Fire*. Transforming the frame from CinemaScope to IMAX.

**Control Tracks** are not typical for consumer media but are used in theatres to automate the curtain or live effects like smoke, lights or rumble. When movies like *The Hunger Games: Catching Fire* (Francis Lawrence, 2013) change the aspect ratio of the image (in this case from CinemaScope to IMAX, see Fig. 8.1) right in the middle, a home theatre version will simply change the height of the image or the size of the letterbox. However, in cinema, the change in aspect ratio often results in a wider or, in this case, higher image, which necessitates the curtains to draw open mid-movie. The screener or other staff do not control this; instead, it is the control track.

**Metadata Tracks** are another type of data that is uncommon in consumer media. In production, data like camera settings, lenses and focus are vital and an integral part of a so-called pro workflow; these are included in metadata tracks.

**Text Tracks** are common in consumer media. They typically store subtitles and most containers support multiple subtitle tracks. Depending on the specific container format, there may be support for compressing the text track. Compared to audio or video, the size of text tracks is negligible.

**Audio Tracks**, along with the video, consume the most space, in some cases (depending on the compression and the number of audio channels and sampling rate) even more than the actual image signal. Containers can typically store multiple audio tracks for the same file, either for localization or different formats like DTS-HD, Dolby Digital or a Stereo Downmix. There are also different supported audio compression formats like mp3, AAC, or even lossless compressed PCM-data.

**The Video Track** is the final track type. Most containers support multiple video streams as well; nevertheless, this feature is rarely used, as in most cases the video is considered the primary track, which is augmented by audio, subtitles and other information.

## Download Versus Stream

It may be surprising, but this separation into single, autonomous tracks is the first property that helps us to distinguish the behavior of a download from that of a stream.

When transferring the file over the network, a stream only contains the tracks that are currently in use (the selected language and appropriate codec settings for the hardware platform) and not all the tracks available. This recombination is ordinarily achieved by re-muxing the tracks on the fly on the streaming server. In contrast, a download usually includes multiple tracks, at least for audio or subtitles.

Distributors often want to include multiple languages for audio, or multiple video qualities and codecs to cover a wide range of audiences. This diversity was established on DVD and later Blu-ray, as they were not marketed to single countries, but—amongst others—to the whole of Europe. While economically not as advantageous as in times when movies were shared over physical discs, this behavior persists in the "cloud age" of content distribution, as consumers have got used to having, amongst others, the native audio track. As with discs, the container file for a purchased download needs to package all the offered content when the file is transferred to the customer. This packaging of all the available content obviously increases the file size. Even if an individual consumer will never listen to the French audio track, it needs to be present for a one-size-fits-all solution, as there is no chance to adaptively change the language otherwise. In the case of a container, this means that the file includes all tracks, and the player software selects the one that corresponds to the viewer's preferences. In theory, it would be possible to include a video that was compressed with different codecs as well. While not generally done, a container could, in principle, contain both an H.264 compressed and another H.265 video track. When played on older mobile hardware, that device could then choose H.264 to conserve battery power, while modern phones would play the H.265 version.

This need for multiple audio, video or subtitle tracks constitutes an advantage of streamed data where bandwidth is concerned. Viewers can choose the language they prefer at any point during playback (as they are accustomed to doing in physical media distribution). While the streaming server has access to all the available tracks that are present in a download, only the ones that are needed for the current playback are transferred to the consumer. We discussed this behavior above,

in the section on the principles of networked streaming. There, the quality was automatically changed mid-stream, but the same applies to language or subtitle track selection. The server hosts multiple video and audio tracks, and either assembles them on the fly or has a collection of preassembled files to fit the needs of the playing software.

This on-the-fly assembly indicates another feature of container tracks that we have not discussed so far: track synchronization and frame interlacing. The latter in particular is a valuable property when we are freely combining different versions of audio and video as described above.

## Track Synchronization and Interlacing

At first glance, a track seems to be comparable to a file in a ZIP container—one for video, one for audio and another one for subtitles. However, a closer look reveals that video files are different. The various tracks have to play in sync, as viewers are very susceptible to the desynchronization of audio and video. Humans readily notice an offset of 50 ms (for a 60 Hz video that is equal to 3 frames) or less. With subtitles, slight differences are not as noticeable, but the effects/control track may be sensitive as well (depending on the effect).

In that regard, the tracks in a video container cannot be considered independent like a file in a ZIP archive. They have to share a common time code that is managed by the container format. While it sounds trivial to maintain a common time code, this is not an easy task to accomplish. Audio and video codecs are separate entities that are not matched. Hence, the time representations stored within the audio or video track are not compatible. Containers unify this time representation, as they "understand" the time present in all the supported codecs. This understanding is the main reason why containers are limited to particular known codecs. The relevant management information is stored in another essential section of the file: the header.

Headers usually encode global information like the author, length of the content, and the list of available tracks with their corresponding types and storage/compression format.

Each track itself starts with a subheader, which includes codec-specific information as well as an index that maintains the entry points[5] for each frame. There are different ways to layout data within a container, which directly influence whether or not a file is playable over a network or not. Since tracks are encoded with independent codecs, the most obvious way to store the data is in sequential order—each track containing the frames in sequential order. This layout is shown in Fig. 8.2a. Admittedly, there is an immediately apparent problem. How do we keep the separate files in sync? To understand why this is problematic, we need to look at data transfers from a disc to a player or over a network. From a high-level

technical point of view, this is the same. We need to open a file (from a disc or a network resource) and start to load the data into memory to decode and play it. The main difference is speed. While reading local data is very efficient on a modern PC, a network is typically slow. To understand the difference, we use the size of Blu-ray Discs as an example. A movie in Blu-ray quality[6] consumes about 50 GB (including all its audio tracks).

When a downloaded 50 GB file is read from a disc for processing, we are usually limited by the bandwidth of the hard drive. We calculate the approximate time to read the entire file based on the fastest single SSD internal storage as of 2020—an NVMe SSD. When attached over PCIe 3.0[7] with four lanes, the maximum bit rate is approximately 31 GBit/s (Wikipedia contributors 2020). Since this bit rate includes the so-called protocol overhead,[8] the bit rate available for the actual data is less. According to a recent benchmark test by a PC-gaming (incidentally one of the most demanding tasks a PC can handle) website (PCGamer 2020), the fastest available SSD can read up to 27 GBit/s. Thus, the system could read the entire file into memory in roughly 15 s.

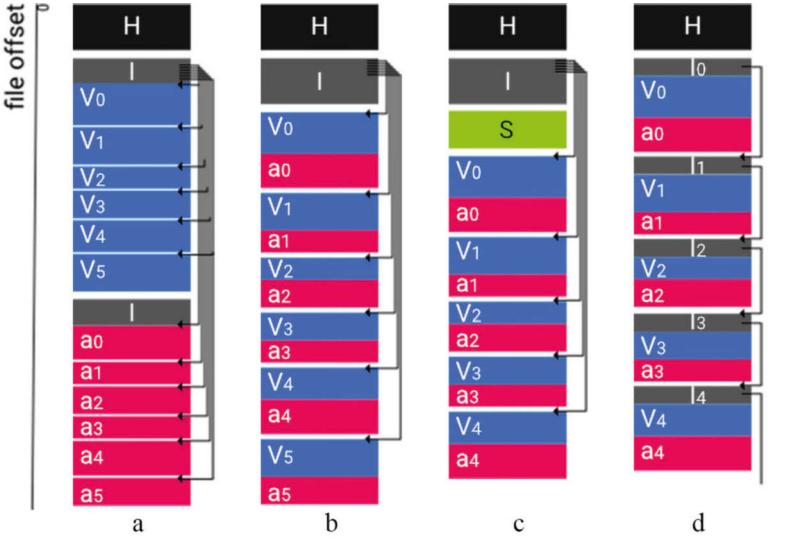



Figure 8.2: a) Tracks in sequential order. b) Interlaced tracks. c) Including subtitles. d) Interlaced tracks without global index

On the other hand, we have a file transfer over the network. A fast consumer-grade cable connection in 2020 can handle up to 1 GBit/s. This bandwidth increases the time for the entire file read to about six and a half minutes.

Let us revisit Fig. 8.2a with that knowledge and the assumption that the video data is approximately twice the size of the audio track. The player needs to download about two-thirds of the file before it has access to the Index Record (IR) for the audio track. This storage layout introduces playback latency (both on the hard drive as well as on the network). However, while the latency on the local drive is about 10 s (which is quite large), the time required on the network is still about 4 minutes—a period most people would consider too long.

Luckily, the situation is not as dire in real life. The header section stores the file offset where we can find the start and types of all the available tracks. When we play the file over a network, we can thus read that header section to find the start of the video and audio tracks and request that section of the file from the server, reducing latency to the bare minimum.

Unfortunately, it introduces another issue. We have to make two separate requests for non-sequential sections of the file—one for the video section of the file and one for audio. It is important to note that non-sequential file reads are slower than continuous reads. This speed reduction may be no problem for a local disc that plays one video at a time. However, a typical video server (or the CDN server that distributes the video) handles hundreds of clients simultaneously, where unordered disc access will pose a significant problem.

The problem stems from the fact that we need information at once from two different tracks, stored at two different locations within a file. Each contains the entire data, like a file in a folder. Fortunately, since the container manages the data, we can change that layout and combine the tracks so that everything we need in order to play a single frame of the movie (or a short sequence) is stored as self-contained and sequentially ordered (see Fig. 8.2b) in a frame package often called a segment. This technique is called data-interlacing, not to be confused with an interlaced scan (in contrast to a progressive scan) often used to enhance the perceived frame rate.

Interlaced data is not desirable for all types of tracks. For instance, a subtitle track does not contain information for every frame but the text for specific time codes. When storing the data interlaced, we would have to repeat the visible text for each frame in order to maintain the guarantee that each package contains all the essential information for a single frame. This constraint would introduce redundant information that increases the file size. In this case, it is preferable to store the entire subtitle stream before the video and audio packages (see Fig. 8.2c). This type of storage increases the start-up time slightly, but considering the small size of a subtitle track, this is barely noticeable.

This flexibility of arbitrarily rearranging the content of a movie is due to the use of containers. Furthermore, while containers were not developed to support streaming, the layouts they allow indirectly influence whether or not media is

playable over a network; which in turn is a precondition to networked streaming and will help us to classify the intent of a file.

## Live Video Encoding

There are situations when it is impossible to maintain a global file index (I in Fig. 8.2c is a global file index that stores the file offsets for each segment available in the file): for example, live video encoding, often found when live-streaming content or when a camera records data. Typical one-to-many live streams are found on Platforms like Twitch (a YouTube competitor with a strong emphasis on live streaming). It was initially focused on watching others playing video games and allows mostly text-based interactions with viewers in real-time. However, the scope was expanded quickly to various live broadcasts from people playing music to doing mundane activities like sleeping.

Another non-persistent, many-to-many live-streaming derivative is commonly used when using Skype, Teams or Zoom.

But why do we need a global index at all? The answer is found in the properties of unordered data. This lack of order manifests as the observation that segments can have different sizes (i.e. due to compression, see Fig. 8.2). Since the video of a live stream is never fully encoded, we do not know the size or count of the individual segments. Thus, it is impossible to calculate the start position of any segment, which precludes us from constructing the index before the entire video is encoded.

This is where things get complicated. The size of the index itself influences the location of the first segment, which would be the first entry in the index. That size depends on the number of segments we need to store, which is unknown when we start a camera recording or a live stream. Even when the video is already known, the number of segments is undetermined before the compression is finished, as, in simplified terms, an encoder creates a segment at fixed time intervals, or whenever the content of the scene changes rapidly (see section on inter-frame compression for more details).

A straightforward way of dealing with this problem is to use a progressive index, as shown in Fig. 8.2d. Instead of having a global index at the beginning of the stream, each segment contains an index that references the previous and following segments. That index has a fixed size (as only two segments are referenced) enabling the encoder to write this structure on the fly. When playing back that live stream, users have two choices: starting at the live edge (the last segment that was encoded just before they started watching) or, hypothetically, from the beginning of the recorded stream.

When joining the live stream at the current time, the server delivers the last completed segment. As it contains interlaced data, it is immediately playable.

Moreover, it contains the address of the next segment as well, which is then requested by the playback software. There is no need for a global index.

Playing the recorded stream from the beginning is also latency-free. The server immediately delivers the first segment of the stream (which is found immediately after the header). That segment references the second one, which references the third, and so on.

The lack of arbitrary positioning in live streaming, as we have described it, violates one of our key properties of streaming that we postulated earlier. To explain this, we need to subclassify the world of networked streaming into volatile streams (which are never recorded by the producer but sent and consumed) and recorded streams. A traditional live stream is volatile. Visitors can only join at the live edge and not start from the beginning or at any other position. For the moment, we will ignore this type of stream.

Recorded streams are another matter. Streamed content is delivered to viewers on the live edge and simultaneously stored on the streaming server for later consumption. However, the resulting recordings do not exhibit a global index, which may introduce lag on later networked playback. This is usually fixed by re-muxing the recording after it finished in order to create a global index for later playback.

## Seeking

Latency is introduced when playing existing videos from an arbitrary position without a global index over a network connection or other slow media like a DVD. This lag was noticeable on older iTunes purchases, where the entire media file was downloaded to the customer before playback was allowed. It is still evident when uploading and sharing unprocessed videos from most smartphones on a personal website. Since those recordings do not contain a global index, playback from an arbitrary position is not immediately possible. Fig. 8.3 shows this behavior (last line on the output) for an unprocessed video recorded on an iPhone 8. The decoder (the playing software) needs to seek three times before playback can start from the beginning. And it gets worse when starting at a random position.

Let us assume we want to start the playback at segment 600 (random access[9] to the 600th element). The software needs to start reading the first element (just as if the client was starting from the beginning of the video) to find the position of the second, then the third and so on (see Fig. 8.2d). In contrast to playing from the start, when the entire segment is read from disc, this seeking operation only reads the beginning of the segment where the index is stored to determine the location of the next segment. Applied to a file played over a network, the system has to either download all the segments up to 600 before playback can start, or the server has to read arbitrary file positions, behavior we established above as bad on the server side.

```
> ffprobe -v debug IMG_3159.MOV
Input #0, mov,mp4,m4a,3gp,3g2,mj2, from 'IMG_3159.MOV':
  Metadata:
    com.apple.quicktime.make: Apple
    com.apple.quicktime.model: iPhone 8
    com.apple.quicktime.software: 12.0
  Duration: 00:00:02.77, start: 0.000000, bitrate: 15926 kb/s
    Stream #0:0(und), 42, 1/44100: Audio: aac (LC) (mp4a / 0x6134706D)
                    , 44100 Hz, mono, fltp, 219 kb/s (default)
    Metadata:
      handler_name    : Core Media Audio
    Stream #0:1(und), 1, 1/600: Video: h264 (High)
                    , 1 reference frame (avc1 / 0x31637661)
                    , yuvj420p(pc, smpte170m/smpte432/bt709, left)
                    , 1440x1080 (1440x1088), 0/1, 13064 kb/s
                    , 30 fps, 30 tbr, 600 tbn, 1200 tbc (default)
    Metadata:
      rotate          : 90
      handler_name    : Core Media Video
      encoder         : H.264
    Side data:
      displaymatrix: rotation of -90.00 degrees
    Stream #0:2(und), 0, 1/600: Data: none (mebx / 0x7862656D)
                    , 0/1, 13 kb/s (default)
    Metadata:
      handler_name    : Core Media Metadata
    Stream #0:3(und), 0, 1/600: Data: none (mebx / 0x7862656D)
                    , 0/1, 43 kb/s (default)
    Metadata:
      handler_name    : Core Media Metadata
[AVIOContext] Statistics: 397093 bytes read, 3 seeks
```

Figure 8.3: Abbreviated output from *ffprobe* showing the number of seek operations for a video recorded on an iPhone 8.

This approach is also problematic when seeking within a video clip, as we need to download all frames until we find the seek position. This restriction would—mainly for streaming media—introduce a significant latency, as starting playback at a random position or seeking through a file would cause the system to transfer all the data between the current and the target positions.

Servers often optimize this and do not send the complete data. In those cases, the server has to perform unnecessary random file accesses when processing the index section of every segment up to the one that will be played. This problem, of course, has a known solution: the global file index, where we can quickly look up the position of the segment we need to play first without seeking through the entire file.

As the first example of an end user's streaming session implied, this behavior (starting playback at random locations and jumping within the content without delay) is an essential aspect of the overall streaming experience. However, this behavior hinges on the ability to maintain a global index. When not dealing with live streaming, this is the premier property a video container needs to offer in order to be classified as streaming media.

The live encoding described above still did not contain a global index, as the generated stream was just a linked collection of segments. Each segment knows the ones immediately before and after, but no other. However, recorded streams will also build a global index while recording, either in a separate file or in memory. In this case, the file system is the container. Individual segments are stored in separate, self-contained container files along with a corresponding global index file. That global index is queried whenever viewers want to play a non-sequential position from the stream. The result is the container file for the segment that needs to be played next. From there on, the segments play sequentially without needing further look-ups in the global index. This way, only seek operations cause a limited number of non-continuous file reads.

### File System Containers

For the most part, we have assumed that a segment is a part of a large container for the entire movie. Nevertheless, as we have just described, a segment could be considered a short clip from the played video, which we could store in a single file instead.

In this scenario, those files are containers around at least one segment, with references to the previous and next file in the video. A global index is also required. Its purpose is the association of playback time with segment files. This file is often referred to as a playlist and can change dynamically, for example when live streaming.

This representation of a container may be unusual, but mirrors the same structure as we have discussed before, as the file system is just another means to arrange data.

## The Influence of a Codec

So far, we have directed our focus onto the characteristics of containers to identify properties that are important for streams. However, the choice of codec settings for a video normally restricts, or at the very least influences, the way we can use it. While specific codec settings might work perfectly well for downloaded videos, the same settings might negatively impact the user experience when streamed over a network. These settings hence further inform our decision on whether a given file is intended for download or streaming.

Before diving into the specifics of codec settings, we first have to highlight a feature of most consumer-grade lossy video compression: inter-frame compression using I-, P- and B-frames.

## Inter-Frame Compression

Fortunately, video data is more than a collection of random images over time. Most frames have a temporal consistency, i.e. the difference between two neighboring frames over time is likely to be small or smaller than the actual stored values. When compressing a video, we can take advantage of this property, as the number of bits we need to encode information depends on the number of different values we need to store. Seven bits allow us to store 128 unique values, while 8 bits double that amount to 256.

Consider two greyscale frames and their brightness values p0 and p1 of the same pixel [compare to Fig. 8.4a]. For this example, we need at least 10 bits for each in order to store the given brightness values p0=612 and p1=532 (10 bits can store up to 1024 distinct values). If we calculate the difference d=p1-p0 = -80, we only need 10 bits to store p0 and 8 bits (7 bits for the value 80 and one bit for the sign) to store the same information. If we also allow a small error (a slight brightness deviation that the viewer will most likely not notice), for example, a maximum error of 8 (out of 1024, which is approx. 0.8 % error), we can save an additional 3 bits when storing the value of d. Hence, we only require 15 bits for storage instead of the original 20.

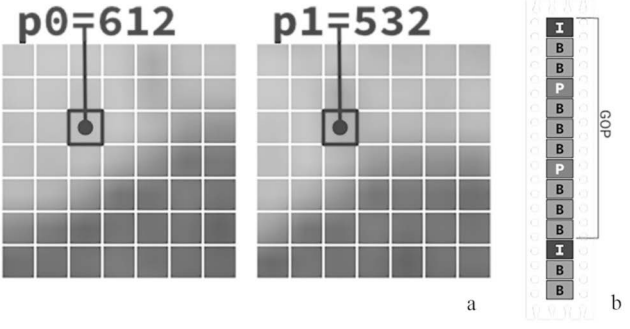



Figure 8.4: a) Two neighboring frames over time. b) Example of a GOP.

Let us apply this technique to an uncompressed 4K, UHD (3840 x 2160 pixels, 10-Bit color depth per channel, no chroma subsampling) video. Two uncompressed frames take up approximately 60 MB of storage. With this simple compression trick, we would reduce the size down to about 44 MB.

This type of compression is no longer lossless and is the basis for most modern video compression algorithms like MPEG2, H.264 or H.265. In 2019, this bit compression gained some attention in the final season of *Game of Thrones* (HBO,

2011–2019). Some dark and moody scenes were mastered for UHD, 10-Bit broadcasting but were then compressed by streaming Platforms (in Germany Sky and Amazon Prime Video) to an 8-Bit format. The high compression combined with color depth reduction resulted in very noticeable banding and block compression artefacts (see Fig. 8.5; we have increased the brightness, since the original image is extraordinarily dark and artefacts are not as visible against the white background of the page), unusual for an otherwise high-quality production. The scene lighting and composition, in this case, is very hard for compression algorithms, as the image content in Fig. 8.5a covers only the darkest range of brightness values. In contrast to the bright page, it almost looks like a completely black image. Difference-based compression techniques always introduce an error in the color and brightness channels of the image. Such errors are more visible in dark scenes with nuanced colors, as humans notice small brightness variance in the dark much better. However, while more pronounced when streaming (due to the limited available bandwidth), this particular problem is not intrinsic to streaming.

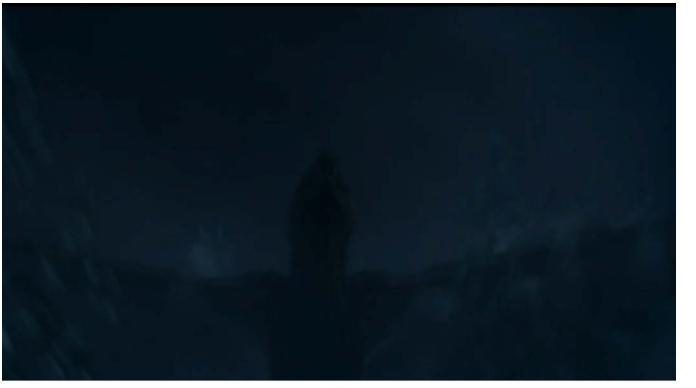
Nevertheless, this restriction is another fascinating point of compression: it may affect creative choices. The producers (and streaming providers) had to deal with some negative feedback due to those artefacts, which could have been circumvented by filming with more traditional lighting, where dark scenes are mostly blue, but still cover a broad brightness spectrum (more akin to Fig. 8.5b). Negative backlash due to technical restrictions can force producers to rethink an otherwise compelling choice.

There is also an economic impact for the stream provider. A popular show like *Game of Thrones* in its final season attracted millions of viewers watching the content simultaneously. This number of views is a strain on the available bandwidth (costing money), which necessitates more robust compression to reduce the load on the servers. At the same time, it will also decrease the perceived quality of the source material, which in turn may drive some customers away from the platform.

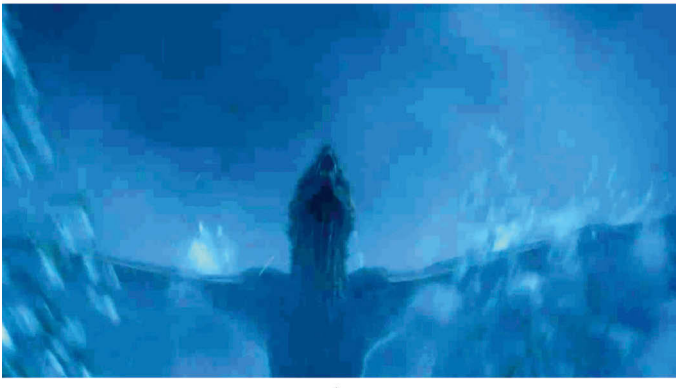
## The GOP

Most video compression codecs derived from MPEG make use of delta encoding by specifying different frame types within a video. In simple terms, those are:

- **I-frames:** store all pixel values as they are. Thus, an I-frame can be decoded without knowledge of the prior or following frames.
- **P-frames:** are encoded relative to one preceding I-frame or another (earlier or later) P-frame. They make use of delta encoding.
- **B-frames:** are encoded using multiple preceding (or following) frames as a reference.



a



b

Figure 8.5: a) *Game of Thrones*, Season 8, Episode 3 at 21:09. b) The same frame with increased brightness.

All dependent frames are arranged into a GOP (Group of Pictures, see Fig. 8.4b), which constitutes the smallest, self-sustained unit of video. Please note that one or more GOPs (and not frames) are stored within the segments of a container along with the corresponding fragment of the audio track, as well as index information. Usually, frames can only be decompressed when the entire GOP is available (in a Network that would mean the entire GOP had to be transferred).

This GOP structure has a vital implication for video playback. It is no longer possible to start playback at any arbitrary position, as the decoder needs the first I-frame inside a GOP or (e.g. with H.265) the entire GOP. GOP size (which is mostly a measure of the number of I-frames) has contradicting implications. Increasing the GOP size (by reducing the number of I-frames or, in other words, increasing

the time between two I-frames) will reduce the size of transferred data while the stream is playing. However, it will increase the data that needs to be preloaded before the stream can start, as the decoder will need to download the entire GOP that includes the desired playback position.

The decision on how much time, or rather how many P/B-frames follow a given I-frame is determined by the compression settings. When encoding a video with H.264, using the popular FFmpeg library, an I-frame is inserted every 250 frames by default (FFmpeg 2020). While this works well for videos intended for download and reduces the bandwidth consumed while streaming media, it has specific implications for the user experience in streaming. For example, when watching a movie over a streaming platform and manually jumping to a random point in time, the server has to send the entire GOP that includes the specified time. The playback can only start after its successful transmission.

While latency may be acceptable, transmission errors in the I-frame may result in decoding errors until the next full I-frame is received. It is important to note that especially streaming media is often sent using UDP, a network protocol that does not offer any guarantee on correctness, completeness or order. This lack of correctness makes streaming data prone to unrecovered transmission errors which (when randomly affecting an I-frame) will have a lasting visual impact until the next I-frame is received.

Assume a brightness that is encoded with one I-frame followed by five P-frames: IPPPPP, IPPPPP, . . . The source material contains the following brightness values for a pixel p over time: 612, 532, 613, 600, 640, 700, 1010 (compare to Fig. 8.4a). Those values are delta-encoded on the transmission side, resulting in the values 612 (first I-frame), -80, 1, -12, 28, 88, 1010 (next I-frame). This sequence is transferred to the viewer; however, due to transmission errors, the transmitted values are changed to 200, -80, 1, -12, 28, 88, 1010. The new sequence would result in decoded brightness of 200, 120, 201, 188, 228, 288, 1010. In this case, the error is visible for 6 frames before the stream can correct itself with the next I-frame. The recovery time from data errors is a critical consideration when compressing video, especially in an unreliable network environment. In the worst case, this amounts to a recovery time of nearly 10 s for the example GOP size of 250 frames. Since streaming is built for networks, this recovery time is another indication that helps us to differentiate a streamable file.

## Reality Check

Please note that in reality neither MPEG2, H.264 or H.265 store the actual color difference. The process is more involved than that, but this simple idea is sufficient for our purpose (Richardson 2004; Schwarz et al. 2014). The actual compression algorithm does not work on a per-pixel basis but (similar to JPEG compression)

on a group of 16 x 16 neighboring pixels (hierarchically subdivided into smaller blocks down to the size of 4 x 4 pixels). For example, the H.264 algorithm tries to identify the movement of blocks of pixels and stores the movement vectors as well as color change coefficients per block. This block-wise compression significantly reduces the size of the resulting images, way more than our simple example. The number of allocated bits the encoder can use to store the block differences similarly determines the quality of the compression.

## Properties of a Stream?

We set out to decide whether a given video source is a download or a stream by just looking at the properties of the transferred media. In the section on the principles of networked streaming, we defined certain key behaviors of a networked streaming experience, namely adjustable quality and content as well as fast playback from arbitrary positions.

A simple solution was found for the random starting positions. The key was the availability of a global index. This index should be stored at a known, fixed position within the file (e.g., after the fixed-size header). But many downloadable files also contain this global index.

In the passages on GOP, we also mentioned that error correction is an essential aspect for a stream. In our example, we stated that an easy solution would be increasing the I-frame count. However, there are better and more complex techniques we have not talked about so far. Most streamed media include checksums and recovery data along with the transmitted segments, in order to enable recovery from degrading transmissions. If either property (global index or error correction) are not available, we can determine that the media is not suitable for streaming. Since those properties are also present in most downloadable content, we need another criterion to distinguish streaming media.

Another impact of the GOP size was latency, which should be as small as possible for streaming. Hence, codec properties like high I-frame counts are another indication of a stream that we will apply.

An additional critical distinction is related to the ability to change the quality and content of a stream dynamically. This is made possible by the container's ability to manage several interlaced tracks in self-contained segments. In fact, considering a segment as a self-contained entity (as described in the paragraphs on file-system containers) with easily customizable content exactly tailored to the users' needs is the chief criterion we will adopt to identify streamed media.

## Divide and Conquer

The critical implication of self-sustained segments is not the fact that they are stored in single files, but that the entire content is separated into smaller segments. Each of those segments should only contain the minimum amount of data that is needed for playback, i.e. only one video and audio track, not all the available languages. However, the selected language or video quality or any other track property can change with each delivered segment (when necessary). During that change, seamless playback (without long delays and repeated or missing content) is maintained.

We can determine the self-sustainability of segments when looking at the file during playback on the networking level. While some downloadable files can be played back during the download, they are delivered with all the available tracks and qualities included. Even when the downloading client allows viewers to jump forward, the data packages themselves are not minimal and have no relation to the content, e.g. if they contain multiple audio tracks. This behavior is called progressive download, not streaming. It is important to note that from the user's perspective a progressive download behaves just like a stream, although the delivered packages are not, and cannot be customized to the specific user settings.

Conversely, a streaming video will always deliver the bare minimum of data in small successive and mostly self-contained segments. Each segment provides all the information needed to play a short fraction of the movie, even if previous segments have been lost. Hence, splitting the video into minimal, self-sustained parts is our primary indication for streamable media.

## Applications

Now the requirements for streaming media have been set, we can investigate some sample streaming applications. The introductory example from the section on the principles of networked streaming already constituted a stream, as we have derived our entire premise from this example. However, there are other examples we will try to classify by applying our rules.

### MPEG-TS

MPEG Transport Stream (W3C Working Group 2016) is a standardized container format that is best known for digital broadcasting like DVB or IPTV. It constitutes a format that can transfer multiple simultaneous streams by packaging the content in small .ts files. Let us check our three properties for streaming against the format's specification:

- Global Index: MPEG-TS is often used for television broadcasting, where changing the playback position is not relevant. Streams will always start at the live edge. The purpose of the global index was maintaining a list of references to all playable positions, in this case, only a single one, the live edge. This information is kept by the Service Information (SI) that is sent along with the Transport Stream.
- Error Correction: As broadcasts are sent over inherently unreliable connections like a radio transmission, error correction is an essential aspect of the format.
- Self-Contained, Minimal Segments: With MPEG-TS a segment has to be assembled from multiple network packets carrying the different tracks (audio, video, subtitles and metadata). Packets include a particular record, the so-called reference clock (PCR), which keeps the packets in sync. From our high-level description, all packets that contain data for the watched stream and are sent after one PCR constitute one segment of data and contain the bare minimum of information. However, this assumption of minimum data is problematic when talking about broadcasting. Since the data connection (for example over the air) is not a 1:1 relation (where the broadcasting station sends custom data to each individual viewer), all the available tracks are sent into the air. The video player will then receive all packets (including ones with unnecessary data), and process those that are needed for playback. When sent over a network connection, however, this problem with MPEG-TS does not arise, as the server can assemble a transport stream that fits the needs of an individual viewer and only includes packages of interest.

MPEG-TS fits our definition for a stream perfectly. The critical observation is that MPEG-TS can be used in such a way that only minimal data is sent. Each segment can contain different combinations of tracks without causing the playback to be interrupted. That is why we classify the format as a stream, as it could be used for streaming.

Here is an appealing implication. The data format of a Blu-ray Disc—MPEG Transport Stream for BD-ROM or .m2ts (Blu-ray Disc Association 2005)—is derived from MPEG-TS with only minor modifications. This relation makes the data stored on a Blu-ray Disc streaming media. Nevertheless, for the intention of this paper, we are concerned explicitly with media sent over a network.

### Cloud Gaming

Recently, multiple platforms started to provide live cloud gaming. The idea is that users do not install and run video games on their local machine but on a remote server. Cloud gaming allows users to experience high-definition video games on machines with low hardware specs. The local machine will record the user input

and send it to a server. That server, a powerful gaming machine, renders high-definition video and audio for the given input, encodes it as a live stream and sends it back to the client. Gaming, nonetheless, poses distinct requirements for the streaming service. In particular, the most crucial factor to immersive gaming is low latency.

Providers of game streaming, therefore, advertise round trip times[10] of less than 70 ms (Fox 2020). For comparison, the latency in gaming on a local machine is in the 40 ms range, depending on the game settings.

The 70 ms mentioned above comprise roughly the following steps: the user input is captured and sent to the server. The server's graphics card waits until previous frames have finished rendering, then synthesizes the new image that incorporates the user input. This last step is identical to gaming on a local machine. However, instead of presenting the result on a display, the frame is compressed and sent to the client. Cloud gaming is a highly individual and interactive streaming experience, as most of the generated images and experiences are unique to an individual player.

The 30 ms difference between local and remote gaming is primarily due to the data transmission; the compression and decompression steps also factor into the additional time cost. It follows that extreme care has to be taken in order to make the compression and decompression as fast as possible. Fig. 8.6a shows some real-world compression examples captured with *PS4 Remote Play* on a local network. As is typical for adaptive quality streaming, the low bandwidth version (320p) both reduces the resolution (320p instead of 1080p) and employs more aggressive compression. The high resolution 1080p is (except for latency) visually comparable to the HDMI output of the console. At first glance, the change down to 320p does not have a significant impact. The image is not as sharp, but for a limited bandwidth network, this signifies an acceptable compromise. Even the "320p-low" version[11] would still be watchable as pure video content. Please note that this aggressively recompressed version shares the same artefacts we saw in Fig. 8.5. However, for games, the quality of the regular 320p compression is often not sufficient. Fig. 8.6b illustrates this problem. The change in compression is not especially visible in this example (the image is separated diagonally). Nevertheless, essential on-screen elements like markers (A), or text (B) are harder to read or not noticed at all. Enemies are less visible as well (C) and often merge with the surroundings (D) due to the image space frequency reduction of the compression at mid-range. When faced with limited bandwidth, the alternative would be a sharp image, at a lower image rate, brief stutters (when new images do not arrive in time) or even a complete picture loss. For gaming, missing images or lost connections are a worse outcome than reduced fidelity.

Similar to regular streaming, the chosen quality depends on the available bandwidth. Yet it is not purely about bandwidth; the latency cost of the compression

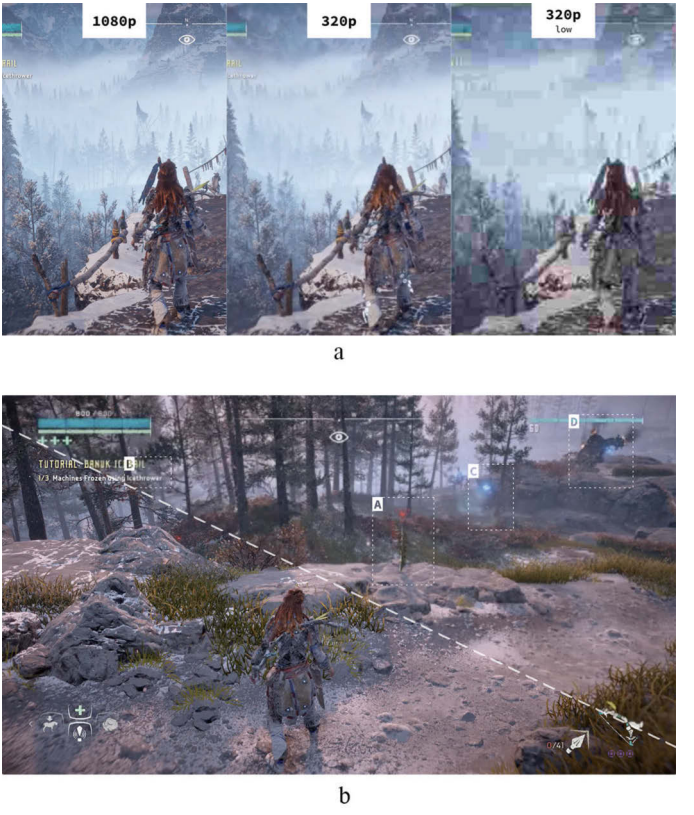



Figure 8.6: a) PS4 Remote Play screen capture of *Horizon Zero Dawn* (Sony Interactive Entertainment, 2017) with different compression settings, b) a detailed look at the impact of compression when playing.

also factors in this calculation. Increasing the visual quality can reduce latencies, as the encoding/decoding steps perform faster. At the same time, this is contradicted by the increased transmission time (less compression results in larger files). In that regard, game streaming needs to strike a careful balance when choosing the right quality settings; just like its video streaming counterpart, however, it relies on adaptive streaming quality.

As we have mentioned, we classify cloud gaming as streaming. Similar to live streaming, it is impossible to change the playback time by jumping ahead or back. This restriction is due to the application, not to the delivered files. As we described above for MPEG-TS, this implies that the global index will only reference the seg-

ment that plays the live edge. The segments themselves are self-sustained packets containing the game's audio and video for a minimal GOP size. Whenever possible, a game stream will use a GOP that contains a single frame (which has to be an I-frame) to reduce latency to the bare minimum. This high I-frame frequency will also result in faster compression and better error handling, as we have described above.

We briefly touched on the topic of volatile streams in the section on live video encoding. The generated segments are entirely transient in this example. The gaming machine (in our example a PS4) will render the sound and images for the given point in time, encode them and package them into a segment—all within the memory of the machine. Those segments are sent to the player over the network, decoded and presented on a display. The data is never stored in the process. In this case, the container format is specified by the transmission protocol, which will have to handle the arrangement of data. Lost segments will not corrupt the entire stream, but are simply dropped during playback.

## YouTube

YouTube is famously known for streaming, as it was one of the first real video streaming platforms. However, in this section, we pick an aspect offered by third-party websites, which allow users to download the videos for local playback. Those sites may use tools like FFmpeg[12] that can take a stream as input and store it in a single file. In general, tools like FFmpeg act like video players. Instead of presenting the content on a display, they convert it for storage.

```
> youtube-dl -F https://youtu.be/XPlIYcWMD4M\?t\=90
[youtube] XPlIYcWMD4M: Downloading webpage
[info] Available formats for XPlIYcWMD4M:
format code  extension  resolution note
249          webm       audio only tiny   54k , opus @ 50k (48000Hz), 699.33KiB
250          webm       audio only tiny   72k , opus @ 70k (48000Hz), 923.88KiB
140          m4a        audio only tiny  127k , m4a_dash container, mp4a.40.2@128k (44100Hz), 1.83MiB
251          webm       audio only tiny  144k , opus @160k (48000Hz), 1.80MiB
278          webm       256x144    144p   99k , webm container, vp9, 24fps, video only, 1.32MiB
160          mp4        256x144    144p  114k , avc1.4d400c, 15fps, video only, 1.61MiB
242          webm       426x240    240p  232k , vp9, 24fps, video only, 2.53MiB
133          mp4        426x240    240p  250k , avc1.4d4015, 24fps, video only, 3.54MiB
243          webm       640x360    360p  425k , vp9, 24fps, video only, 4.61MiB
134          mp4        640x360    360p  604k , avc1.4d401e, 24fps, video only, 5.15MiB
244          webm       854x480    480p  787k , vp9, 24fps, video only, 7.97MiB
135          mp4        854x480    480p 1110k , avc1.4d401e, 24fps, video only, 10.15MiB
247          webm       1280x720   720p 1544k , vp9, 24fps, video only, 15.98MiB
136          mp4        1280x720   720p 2257k , avc1.4d401f, 24fps, video only, 19.38MiB
248          webm       1920x1080  1080p 2737k , vp9, 24fps, video only, 29.50MiB
137          mp4        1920x1080  1080p 4242k , avc1.640028, 24fps, video only, 36.96MiB
264          mp4        1920x1080  1080p 6951k , avc1.4d4028, 24fps, video only, 61.08MiB
18           mp4        640x360    360p  636k , avc1.42001E, 24fps, mp4a.40.2@ 96k (44100Hz), 9.18MiB
22           mp4        1280x720   720p 1470k , avc1.64001F, 24fps, mp4a.40.2@192k (44100Hz) (best)
```

Figure 8.7: Available streams for the previously mentioned *The Hunger Games*-video.

The first definition of a stream we encountered was characterized by the volatile nature of the data. In that regard, the tool used was the deciding factor whether or not the data was a stream. Consider the YouTube example: when videos are played in a browser (like Safari, Google Chrome, Edge or Firefox), that definition will classify the experience as streaming, as the segments received from YouTube are played and immediately discarded. If the same input is consumed through FFmpeg, and watched at a later point, it is classified as a download, because the same transferred data was then stored. But why would the same content be classified differently? The data sent from YouTube is always a streaming format that meets all our criteria. YouTube hosts the same content as multiple single files that are created using different codecs for compression (see Fig. 8.7). Those files are created in such a way that the server can switch seamlessly between segments from different files during playback in order to change the quality. Like the video player inside the browser, FFmpeg can start capturing the stream at any point in time, without delay, and change the quality (or content if available) at any point. The transferred segments are self-contained and minimal, and the built-in error correction is still applied (as it is when playing the video on the YouTube website). We can even configure FFmpeg to generate a copy of the streamed segments by storing the data as, for instance, an MPEG Transport Stream. However, the resulting files will lose the ability to change quality or content seamlessly. The decisions made when the file is played (even when played using FFmpeg) are an integral part of the created file.

In that sense, FFmpeg transforms the data into a new format. While the source data remains a stream, the data has undergone another transformation that changed its purpose from being a stream to make it into a download. For example, when storing the result as a .mp4 container, the file will (at least when using the default FFmpeg settings) lose the global index. Without it, it is impossible to play the file over a network without noticeable delay.

This transformation happens all the time to videos moving through the cloud. They start as source material from a camera, are edited to a completed movie and then distributed as downloads to streaming companies, broadcasters or cinemas. A streaming service will then transform the video to create a format that is suitable for streaming. In this final illustration, the end user receives the streaming data and converts it back into a downloadable format. Nevertheless, the process of receiving the data was still streaming. This result contradicts the initial assumption, as the resulting file is no longer volatile, but a permanent file on the receiver's hard drive. It is only if that file is then reoffered over a network, such as by a conversion website, that the following transfer will constitute a download.

## Conclusion

There are a lot of intricacies and small details of various systems at play that contribute to the generic streaming experience. While we have been able to narrow down the inherent characteristics of containers and codecs that qualify video content for potential streaming, we have also left a lot unwritten: e.g., the role of server software or network protocols like HSL, RTMP, Dash or WebRTC, which are an essential aspect when implementing (live) streaming. However, for the purpose of our discussion—classifying media as a stream or download based solely on the properties of the files themselves—this is unnecessary detail.

The most relevant message is the importance of container formats when processing or consuming video. Containers act as a proxy that can combine otherwise unrelated codecs (like MPEG Audio Layer III and H.265) into a working video experience. They bridge the gap between the server and the player software and transport information that allows us to view multiple media types in sync. Without containers it would be impossible to move video and audio through the internet in sync.

This flexibility constitutes a significant trade-off when distributing media. Most modern browsers enable regular and progressive downloads, making it easy to share short clips with the world by simply uploading videos to any web host.

Streaming, nonetheless, requires specialized software on the server and on the part of the client that handles the end customer delivery as well as the media conversion into an appropriate, streamable format. On large streaming providers like YouTube or Twitch, this added complexity on the server is hidden by a specialized and uncomplicated User Interface that accepts any uploaded movie from the client and transcodes or (where possible) re-muxes it into a streamable format with different, default qualities. That server also takes care of recombining tracks into minimal segments. The player software (either the web frontend or dedicated mobile apps) is tuned to that same server to provide the ability to switch resolutions without any noticeable gaps in playback. Using that UI makes streaming as simple as providing downloads, while it generates lock-in to large streaming or video portals.

Although it is technically possible to recreate that service for a personal VLog, most YouTubers or Twitchers do not possess the required skills to implement this; a simple fact that puts leverage into the hands of large streaming platforms, creating an imbalance in power, which is often addressed on the streaming platforms themselves whenever seemingly arbitrary rules are imposed on the creatives.

The concentration of creative media on a few large video platforms also impacts legislative regulations. While it is hard to impose rules or block every website on the internet, it is easy to block or establish laws that force the largest streaming platforms to uphold precepts. This simplification is arguably good when upholding

common law, but it also simplifies censorship, as has been evident, amongst other cases, in Turkey (Letsch and Rush 2014) or Germany (van Buskirk 2009).

Indeed, the complexity of streaming, especially at the beginning of user-created videos, is not the main reason for lock-in. Factors like reach and monetization are more critical to creatives. Nevertheless, it is still surprising that a proprietary platform like YouTube has emerged amidst the open web. If more accessible, open technologies like HTTP Streaming or HSL,[13] had been available earlier, this might have played out differently.

There is another advantage of large video platforms that may have a direct impact on the transportability of media. As we discussed above, the codec of a video can impact energy consumption and user experience. A collection of decentralized video downloads (for example privately hosted on a web server or previously downloaded from storefronts or other distributors) would be very hard to convert into more energy-efficient or better compressed, and thus smaller, formats. Large video providers, on the other hand, could have a positive impact by converting videos with large audiences to the best available codec before streaming the content. This centralized approach would limit both the required bandwidth (an economic advantage for distributors as well as consumers) and the energy footprint of their viewers.

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## Notes

1 A cache is an automatic system included in most browsers to speed up page loading while surfing. Previously downloaded data remains on the local hard drive. When the same content is viewed again, the data is not loaded from the server but from the local cache.

2 The last iPhone that did not contain hardware to decode H.265.

3 Roughly the speed the device has at its disposal to receive video.
4 While JPEG is commonly referred to as the file format, it is a compression algorithm. The container format found in .jpg-files is called JIFF or Jpeg Image File Format.
5 The location of the track in the file, also known as the file offset.
6 Usually, H.264 is encoded FullHD, 8-Bit color-depth with 4:2:2 chroma subsampling at 30 Hz.
7 PCIe 3.0 is a hardware protocol that manages data transfer from PC peripherals like storage or graphics card to the CPU for processing. Currently, we are transitioning to PCIe 4.0.
8 Data that is sent to control the storage device or as checksums to validate the data integrity.
9 Random access is a term from computer science. It describes the fact that ordered data is not accessed in a predefined pattern (for example, sequentially from start to finish) but in an unpredictable order.
10 Similar to latency, the round trip time indicates the amount of time between the user's input and the playback of the frame showing the result.
11 This is not a compression allowed by PS4 Remote Play. The lowest quality the service provides is the result shown as 320p. For this "320p-low" version, we recompressed the original image using FFmpeg to produce the last example.
12 In combination with the *YouTube-dl* script.
13 At the time, streaming with flash, another proprietary format, was commonly used.

# Trajectories and Traces

# 9. What Moves? The Itineraries of Pre-Digital Photography[1]

*Michelle Henning*

It seems self-evident that photographs are still. The language of fixing, of the freeze and the slice in time has long been used to characterize photographic images. Before digital images, photographs were contrasted with "moving pictures"—with film and television. The tendency to treat photography and film as separate media makes sense from the point of view of consumption, but not when we take into account their shared technology and means of production. Nevertheless, the story goes that in the analog era, photography and film were separate media, one still and one moving, but in the digital era, they converge on the liquid crystal screen. This idea, that the chemical, analog photograph is by nature static, relies not only on a contrast with film but on a comparison to its digital counterpart, which is regarded as mobile, malleable, transitory, virtual and immediate. After all, for most consumers and makers of digital images, the same cameras and platforms are used to make and view still and moving images, and while we might term one "photo" and another "video," the two can be indistinguishable except in that one moves. The introduction of "live" photos makes the distinction even hazier. Furthermore, since they appear and disappear at the touch of a finger, and since the colors on a screen are constantly refreshing, perhaps no digital screen image can really be classified as still. As Ingrid Hoelzl and Remi Marie suggest, "the image is always potentially moving" (2015, 23).

If the digital photograph is never really still, by comparison, the pre-digital, analog or chemical photographic image appears as fixed and static, characteristically immobile, a frozen piece of the real. This portrayal of chemical photography, which can be found across a wide range of writings on the digital image, assumes that what preceded digital was primarily a technology of the photographic print. It neglects the transparency or the negative, or the various ways in which photographs are mediated in order to be reproduced in print media or transmitted across the world. My interest here is in the transitory aspects of the "still" photograph, not its animation (or its relation to cinema) but its lack of fixity as a medium and how this challenges the characterization of photographs as frozen moments and slices through time. In previous writing, I have drawn attention to chemical

photography's role in unleashing images from their fixed place in time and space: through reproduction and circulation, transmission and projection, fragmentation and decontextualization (Henning 2018). I take the view that it matters that we recognize the mobility and liveliness of pre-digital photographs, in order to better acknowledge the diversity of contemporary and historical images and practices and to understand the continuities as well as the breaks between new and old forms of photography. In particular, I want to question overused distinctions between the material and the "virtual," the static and the mobile, that underpin divisions between analog and digital.

The notion of the fixed, still, frozen image is inseparable from other persistent ideas about photography that deserve interrogation. These are specifically about its relation to time and experience. It has often been noted that photography has participated in a historical transformation of experiences of temporality and processes of remembrance (Kracauer 2014, 40). The photograph, conceived as a preserved instant, seems to stop time, prosthetically substituting for and extending our memories, but also to break the continuity of time by slicing it into ever finer pieces. The snapshot's "pastness" becomes its defining characteristic. Even before photography was invented, the photographic image seems to have been anticipated as a snippet of reality, fished from the flow of time (Batchen 1997, 84). The idea of the photograph as a frozen moment seems to suggest a series of moments like beads on a string, each bead corresponding to a photographic exposure. Yet, the length of a photographed moment can vary considerably, from a matter of hours or even days to thousandths of a second. As Chitra Ramalingam points out, "most early photographs were essentially durational in character. Single instants were buried in the aggregation of impressions over time" (2015, 341). There are other temporalities of the photograph, too: to print a positive from a photographic negative requires a second exposure time, and the development of both positive and negative requires various amounts of time for developing and fixing. To treat a photograph as a real moment, grasped, is easy to do if the image represents a younger self, a past event, a now-dead relative. But to make this the defining quality of photography is misleading. So, for example, we might rightly wonder in what sense a photograph is usefully interpreted as a representation of the past, if it has no specifically historical content, or in what sense it represents a "moment" if we cannot know how long the shutter was open, or in what ways it was constructed through the dance of light under an enlarger or the mixing and control of chemicals in trays.

We have continued to regard photography as primarily a means for recording reality, defined by its relationship to the objects in the world that it depicts (so that for some a photograph can never really be abstract, or if it is, it is not a photograph). Cameras are thought of as mechanical eyes, photography as a technology of seeing, a transparent medium that we look "through" to reality (Huhtamo 2018; Henning 2018). The term "fixing" is used to describe both the pinning down of subject matter

by the camera, and the stabilizing of the image on the print or film. These two types of "fixing" do not have any necessary relation to one another: it is not a condition of snatching a moment that it must subsequently be permanently preserved. But through this slippery term, a photograph's stasis is envisaged, both in terms of what is represented in the image (a fleeting moment made to last) and in terms of the characteristics of the print (as something unchanging, of relatively solid and permanent form).

Both are truisms only if we accept that photography's social significance rests primarily on this ability to preserve or record reality, bracketing off the ways in which the process encodes and translates its subject-matter, and if we ignore the exceptions, such as the abstract photograph, the long exposure photograph, the projection, the badly fixed and fading print. Even while image stability is desired, it is not easily achieved, as indicated by the efforts made to prevent photographs fading or render them stable—from the Photographic Society's "fading committee" in nineteenth-century London to the experiments of the industrial laboratories of companies such as Ilford, Eastman Kodak, Agfa, and Polaroid, and the ongoing work of archivists (Schwartz 1996, 94; Henisch and Henisch 1994, 92). As Hoelzl and Marie write: "The concept of the photo (or film frame) as an immobile cut through abstract time, does not consider the fact that photographs (as objects in time) are also subordinate to time, even if the change occurring and observable is usually very slow" (2015, 17).

Classic photography theory is born of a particular moment, of the era of snapshot and "instant" industrialized photography, of a particular historical set of practices and genres (family photography, reportage, documentary), and alongside the rise of a specific kind of modernist, humanist and "candid" aesthetic. It is preoccupied with questions of time, realism and memory, in recognition of the ways in which photographic media had dramatically transformed people's relation to their own past and to the visible world, in little more than a century. More recently, this idea of photography as a mnemonic practice has been linked to the vast accumulation of vernacular photographs, which stockpile experience to the point that the sheer volume of the recorded past seems to overwhelm the present (see the discussions in Dvořák and Parikka 2021 and Lewis and Parry 2021, forthcoming). However, a number of recent writers have challenged the dominance of certain key notions in photography theory: of the photograph as a mnemonic and rather melancholic object associated with death; of the photograph as an imprint of the real; of the snapshot as the epitome of photography. For instance, Peter Buse has noted that the emphasis on memory in relation to snapshot photography acted as a useful corrective to the art historical approaches that preceded it but "like any dominant way of thinking, this one has the potential to cut off other areas of investigation" such as "photographic practices that are not in the first instance to do with memory" (2016, 21). Summarizing a wide range of writings preoccupied with

the mnemonic function of snapshots, Buse notes that this is also an emphasis on the partiality and unreliability of photography and a general melancholy in which: "even the most straightforwardly happy of family snaps is shadowed by loss, lack and death" (2016, 28). In my own writing, I have considered how an analogy between photographs and death masks recurs across a number of writings on photography, and emerged out of a particular style of photography, and the specific social and cultural context of interwar Europe (Henning 2017). In *Life After New Media*, Sarah Kember and Joanna Zylinska argue that photography needs to be seen "as more than a series of frozen 'snapshots,'" and they mobilize Bergsonian notions of vitality and ongoing mediation against the more common theoretical association of photography with death (2015, 71).

Attention to the mobility of the photographic image and of photographic practices has been gaining traction recently. The broader recognition that we now experience media on the move, meaning both on devices that we carry with us as well as in temporary instantiations conjured up on a screen, has allowed us to reassess photography as a media-form which had no fixed location even prior to digitization. For Erkki Huhtamo, for example, a consumer box camera such as the Box Brownie, "could well be described as the first true mobile medium" (2011, 27). Rachel Gillies takes the term "mobile photography" to refer both to the use of smartphones, and to photography as an inherently mobile medium, albeit one whose mobility has been radically extended in its transition to digital devices and screens (2020, 213). Hoelzl has argued that we should think of "photography not as a time-less but as a time-based medium" and that movement can be traced "at every stage" in the practice of photography through to its circulation and reception (2011, 2–3). Kember and Zylinska redefine photography in terms of its "potentiality" and its processual, performative nature, treating it as a practice of "cutting," of managing temporality or duration rather than of reducing a (mobile, transient) world to static representations (2015, 71–81). They still regard photography as a means to produce "graspable entities," but these are only temporary stabilizations (Kember and Zylinska 2015, 76, 82–8).

While many of these writers have shaped my thinking about photography as a mobile or kinetic medium, here I want to pick apart the story which posits an old medium as static and fixed and views its replacement as dynamic, dissolving and insubstantial. In particular, I will try to approach the mobility and temporality of the photographic image in terms of its ability to be disassembled and reassembled, its disintegration into particles, its ability to disappear and reappear, moving from one substance or surface to another. This involves attending both to the actual properties of the medium and the cultural frameworks through which we understand it, and it will require situating photography within broader theories of capitalism, modernity and media. In the next section of this chapter, I address how theories about capitalist modernization link a kind of dematerialization to

an acceleration of experience, and how this has affected how photography's own speeding-up has been understood. In the third section, I pay attention to arguments about automation and how the pixels or grain of a photograph are linked to its ability to be dissociated from a specific surface. This is followed by a discussion of noise, as something which results from the movement of images, which connects media with the incorporeal or immaterial (the spirit world) and which at the same time reveals the impossibility of pure communication uncontaminated by the material infrastructure that produces it.

## All That is Solid

One of the most compelling and much-repeated phrases from *The Communist Manifesto* is "all that is solid melts into air" with its implication that capitalism involves a kind of dematerialization (Marx and Engels 1968). Of course, it is a metaphor: tradition is envisaged as solid and static, while capitalist change and the destruction of tradition is envisaged as dissolution or vaporization. This story of capitalism and of modernity resonated, in the nineteenth century, with certain technological developments and scientific discoveries including the invention of the telegraph and of photography. The vision of capitalism as dynamic, mobile and destructive is shared by one of the early proponents of neoliberal economics, Josef Schumpeter, who conceived of entrepreneurship driving innovation through "gales of creative destruction" (1942). Even today, capitalist economic cycles are described in terms of "growth" and "stagnation" (types of movement and stasis). The dependence of ideas of modern mobility on ideas of stasis-as-stagnation is evident in economic discourse, as is the way that innovation goes hand in hand with the production of obsolescence. Modern capitalism produces casualties—including people and ways of life—which do not disappear altogether but are treated as if outside time, obsolete and outmoded leftovers (Watkins, 1994). Technical obsolescence is grasped in these terms, too: hardly surprising then, if since the 1990s, digital photography has been characterized in terms of dynamic mobility, while the older chemical photography seems to be both about the past and of the past, obsolete but also always inherently backward-looking.

Marx and Engels' phrase captures the sense of destabilization and loss of traditional ties and roots that accompanies rapid social and technical change. This experience is understood by theorists both as the experience of modernity, and the modern experience of historical time (see for example Berman 1983; Harvey 1990). In periods of technical and industrial change, there is a sense of acceleration, of ever more rapid change, of a hastening of time. This experience of acceleration reshapes both the past and the future. It is born of a specific kind of historical consciousness which, writers such as Reinhart Koselleck have argued, developed out

of revolution, globalization and colonialism. It is manifest in the ways in which Europeans mapped their own historical experience onto other cultures, so that nonindustrialized cultures came to be seen as simultaneously contemporary and belonging to the past (1985, 247). The concept of progress is inseparable from the modern experience of acceleration. Time is conceived as a moving forward, and a gulf opens between the present, the past and future (Koselleck 1985, 251). The connection between modernity, accelerated time and movement was made explicit by the Prussian historian Friedrich Ancillon, cited by Koselleck, for whom the experience of modernity was the experience of things being "set in motion" and the love of modernity was "the love of movement in itself, without purpose and without specific end" (Ancillon 1828, cited in Koselleck 1985, 251). This sense of transience induced by modernity, which destroyed an older sense of cyclical time, informed the Romantic attachment to fleeting sensation and ruins, which is linked, by Geoffrey Batchen, to early nineteenth century photographic experiments (1997, 84; 2002).

Most writers on modernity see the nineteenth century as the period in which stability became the exception rather than the rule of social existence (in the West), and many agree, as Bernard Stiegler writes, that "technics, as technology and techno-science, is the chief reason for this reversal" (Stiegler 2009, 1). For Stiegler, accelerating technical innovation means that technical information systems outstrip existing social organization, transforming not only culture but memory and psyche (Stiegler 2009, 3).[2] For Zygmunt Bauman, by the late twentieth-century a newly volatile "fluid modernity" is permeating every aspect of daily experience and social life, disintegrating collectivities and dismantling community, dissolving bonds of family and introducing new nomadisms (1999, 7–13). Bauman links this falling-apart of social relations with a growing disposibility and instantaneity of goods and technologies. Theorists of globalization conceive of the movement and mobility it entails in terms of "flows," that is, "flows of capital, flows of information, flows of technology, flows of organizational interaction, flows of images, sounds and symbols" (Castells 1996, 412). For Bauman, the fluidity of this new phase of modernity means it might only be described in "snapshots, and they need a date at the bottom of the picture" (1999, 2). He evokes the snapshot photograph as a temporary, provisional account of something which we know will have moved on since. Snapshot photography in this sense is the medium born of, and most suited to representing, a new form of experience that does not lend itself to slow, considered representation.

Automation and the spread of electronic media are understood by numerous theorists as contributing to a growing impression (or illusion) of dematerialization. The idea that a movement toward dissolution is characteristic of capitalism is developed by autonomist thinkers such as Franco "Bifo" Berardi, who views computerization as rendering labor increasingly "immaterial," distributing it beyond

the workplace and into everyday affective experience, with devastating effect on human experience—as the limitless speeding-up of information processing meets the limitations of people's capacity to handle and respond to it (2009). New forms of accelerationist theory reverse this, characterizing contemporary global capitalism as depleted, flagging and stagnating, and seeing emancipatory potential in acceleration (Gardiner 2017, 33).[3] Despite significant differences, most of these theorists concur in their diagnosis of late capitalism and liquid modernity as both accelerating and destructive. Contemporary theory diagnoses a speeding-up of transport and communication, and of the pace of life in general, alongside increased productivity and increasingly fast cycles of fashion and cultural change, even while it also diagnoses an underlying inertia and repetition (Rosa and Scheuerman 2013, 5–7). The sense of accelerated time is invariably linked to fragmentation, liquefaction, dissolution or disintegration: things fall apart.

It seems likely that theories of modernity as accelerated temporal experience follow modern science in linking movement and speed with disintegration or liquefaction. In physics, the movement of atoms and molecules is linked to a change in state from a solid to a liquid or gas, or from cold to hot, and the theory of entropy suggests an inexorable movement toward disorder over time. However, when the acceleration we are describing is the experience of historical time, the movement from "solid" to "liquid" or even from "material" to "immaterial" is largely metaphorical ("immaterial labor," for example, does not imply that labor is not embodied or does not have material effects). The solids that melt into air, or liquify, are traditions, ways of life, values and beliefs, institutions and hierarchy, things that are not tangible objects, but were felt to be "solid" because they were long lasting or seemed indestructible. Metaphors of liquefaction, disintegration, dissolution or evaporation are a means to make sense of periods of rapid change, and the loss of familiar anchors and routines.

In the case of electromagnetic media, the connection between speed and increased intangibility is literal. To accelerate information flow, from the nineteenth century, media began to harness forms of radiation that could permeate solid walls and cross national borders. By the 1870s, this mediated flow of information was speeding up capitalism, via the ticker tape telegraph system used in finance houses and stock exchanges. During the twentieth century, as media became increasingly computational, their temporality came to depend on processing time: thus, the human experience of an accelerated modernity is dependent on the micro-temporalities of "time-critical" digital and electronic media, the workings of which were increasingly black-boxed, and which rely on invisible and intangible forms of transmission (Ernst 2005; Parikka 2011). Fast information flow, whether analog or digital, appears to be accompanied by a relative dematerialization insofar as the dissolution of the image into signal, wave and particle is what allows it to travel.

The familiar narrative of modernization as acceleration also plays out in theories of digital photography, which emphasize the speeding-up of the taking and viewing of photographs facilitated by digital processing. However, in everyday experience, digital photography actually introduced a new slowness, in the form of a frustrating delay, noticeable in early and lower-priced digital cameras, between the pressing of the shutter release button and the taking of the photograph. It is the case, though, that photography (both digital and analog) became faster over the course of its history, in the sense that increased film sensitivity, finer lenses, and electronic shutters made possible ever-shorter exposure times, supporting the impression that the photograph itself was a slice of time. As early as the 1850s, London photographic studios were advertising "instantaneous photographs," a phrase which emphasized the convenience to customers (since the whole process would be quick) but also the modernity of a technology characterized by speed (Skaife 1860, 9). The attraction of the instantaneous as characteristically modern was linked to developments in other technologies, particularly electricity and telegraphy, and to studies of the human nervous system (Henning 2018, 46; Canales 2009, 25–26; Morus 2000, 459).[4] By the early twentieth century, the shortening of photographic exposure times and processing times was being driven by a combination of commercial and military incentives, including state-funded research into sensitizing dyes during the Great War.[5] In other words, the speeding up of photography was not a technical inevitability but was overdetermined by the larger narratives and practices of capitalist modernity and consumer culture, in which acceleration, innovation and instantaneity were central concepts.

## The Discrete and the Grainy

Even those theorists of photography who challenge simple divides between analog and digital tend to view photography as moving inexorably towards a kind of dematerialization. In some accounts this is associated with the black-boxing of the technology, for example in Kaja Silverman's account of photographic history as a move away from the "wet" chemical technology of early photography towards a "dry" photography (in a reversal of Bauman's increasing liquidity). Photography's dry spell begins with the commercial dry plate and the factory-processed film and continues into the black box of the digital camera. As Silverman summarizes, through a reading of Jeff Wall's seminal essay "Photography and Liquid Intelligence," chemical photography's reliance on fluids, its "liquid intelligence," makes it seem unpredictable and uncontrollable, whereas ever "drier" photographic technologies appear to drive towards a "cool," more rational and controlled image (Silverman 2015). This is not a simple opposition between analog and digital; dryness is associated here with a growing gap between production and consumption, an increasing automa-

tion and, from the photographer's point of view, a more "hands-off" and ocular approach, in which the material resistance and messiness involved in "making" a photograph is replaced by the quick, clean act of "taking" a photograph.

Wall/Silverman's wet-dry distinction alludes to the way in which, even in digital, photography's messy physicality is not entirely expurgated but rather displaced to an elsewhere: to manufacturing plants and mines that are not visible to the photographer. But the assumption that digital represents a step toward greater rationalization and control underestimates (for example) the technical complexity of photographic film manufacturing which makes use of very refined automated processes of precipitation and ultrafiltration to precisely control the grain of the image. To see the "dry" image as more rationalized reinforces one of the key fallacies of the analog-digital distinction in photography: the tendency to view analog as less automated and less industrialized.[6]

Vilém Flusser, writing in the 1980s, understood changes in automation and the rise of an information economy as producing a new mobility in images, which disassociated them from specific material surfaces. He argues that the automation of work, and the transformation of human labor into the labor of machine programming (characteristic of what he called post-industrial society), means the end of cultural objects. This is because cultural objects, as he defines them (in a mix of Heideggerian and Marxist thinking), are objects given value through human labor; and in the context of post-industrial information society such objects "become almost 'value-less' supports for programmed information" (Flusser 1986, 330). Flusser's prime example of a post-industrial object is a photograph which carries its information "on its surface and not within its body," and this information "may be transferred easily from one worthless surface to another" (1986, 330). The camera, in turn, is not simply a machine but an apparatus which "elaborates information." In this way, Flusser sees photography as a key medium in the shift toward an information-based, post-industrial society, suggesting that this is merely consolidated in the move from chemical to electromagnetized photos (Flusser 1986, 331).

According to Flusser, photographic images have a relative independence from the physical surface on which they appear, which distinguishes them (and all other technical images) from traditional (i.e. handmade) images. Technically, this is not strictly the case with photographic prints, the visual characteristics of which are determined not only by the negative and enlarger but by the type of paper and the qualities of the photographic emulsion. The image does not sit on the surface, as Flusser seems to imply, but as Ramalingam points out, the photograph is "laminar," made up of different "strata" which determine the appearance of the image and how it changes over time and in different environmental conditions (2015, 319–320).

For Flusser, the break between chemical and electromagnetic images is not as significant as the break of both from traditional images. He emphasizes the particle-based nature of technical images: from the grains on a chemical photograph to

the points of light and color on a television, "all technical images have the same basic character: on close inspection, they all prove to be envisioned surfaces computed from particles" (Flusser 2011, 33).[7] However, early theorists of the digital image see a key difference at the particle level, between the grain of the chemical image and the pixels making up a digital image. They distinguish the irregular grain of photosensitive emulsion, with its infinite tones, from the pixels of the digital sensor, all of identical scale and countable (Mitchell 1992).[8] The difference in these photosensitive surfaces, and how they store information is a foundational distinction between analog and digital cameras, since the process by which light enters the camera remains the same. Bernard Stiegler suggests that the key difference is that digital images can be disassembled and reassembled, while the chemical or analog photographs cannot, even though they too are "always already discrete" (Stiegler 2002, 155–158).

Some writers have suggested that technologies predating digital photography can be seen to increase the discreteness of photography, for example, the half-tone system required for the "mass circulation of photographs . . . imposed for the first time a grid structuring the grain of the image" (Cubitt, Palmer, and Tkacz 2015, 9). However, this kind of explanation of the birth of photography as a mass reproducible and standardized medium, first via the half-tone screen and eventually through the pixel array, with its distinction between random particles and rationalized grid, retains the misleading impression that analog photography is craft-based rather than something that itself becomes highly industrialized and standardized.

In information theory a discrete process is simply defined as having a limited set of symbols or values and a finite range of allowable sequences, a set of rules that allows for encoding and compression (Shannon and Weaver, 1964, 34–6). The particulate nature of the technical image is key to its mobility (its reproducibility, its transmitting ability). Discreteness, manifested in the regular grid of the half-tone screen or pixel array, enables greater encoding and compression, key factors in the transmissibility of images. However, the grains of a technical image do not necessarily point to a separation of information from material support. Insofar as they also act as indices of "noise," they suggest contamination or damage to the image or its material limitations. For example, across both pixel and crystal-based photographic technologies, low light affects the appearance of grain.[9] Generally and very broadly speaking, the lower the light, the more visible the grain of the image and potentially the more noise (drop-out or "artefacts" in digital images). Noise becomes an indicator of the physical constraints of the medium itself.

## Snap and Crackle

Noise in the image also reveals that it has travelled. It is the accumulated dirt of the traveller. As Hito Steyerl famously argues in her "In Defense of the Poor Image," the poor-quality digital images that circulate on the internet are a product or side effect of the fetishization of high-resolution (rich) images, the privatization of intellectual property and the commercial market for media. Noise, like dirt, accrues to the devalued, but it also gathers with speed, as Steyerl asserts in her opening sentence, "The poor image is a copy in motion. Its quality is bad, its resolution substandard. As it accelerates, it deteriorates" (2009). Acceleration, for Steyerl as for others, is associated with dematerialization: "Poor images are poor because they are heavily compressed and travel quickly. They lose matter and gain speed" (2009). If Steyerl seems to agree that poor images take to the extreme the tendency Flusser identified in photography—to detach information from its material support—she also suggests that in the process they encounter a different kind of materiality in the form of noise.

The belief that media might provide a means to communicate with ghosts or aliens often relies on the ambiguity of noise. In the twentieth century, the "snow" in analog television and the crackle of radio both seemed to suggest that it was possible to see or hear beyond the channel, to access other worlds—an idea dramatized in the film *Static* (Romanek 1986), in which the principal character is convinced he can see Heaven in the white noise of television. Similar esoteric understandings even gained a scientific basis after the 1965 announcement of the discovery of the "cosmic microwave background" (CMB), which was picked up by radio and television antennae as "noise" and considered by cosmologists to be radiation produced by the Big Bang.[10] The idea that in looking at television static or "snow" we are witnessing the beginning of the universe, feeds into a fascination with the accidental and nonhuman elements of media. Beliefs and practices centring on cosmic or spectral communication through media are sometimes seen as the consequence of a misunderstanding of technology and science, or a human response to the unsettling pace of change in modernity. However, Bernard Geoghegan argues that our willingness to perceive ghosts in the machine is linked to the failure of the technological promise to provide smooth and uninterrupted communication (2016, 900). He argues that nineteenth-century spiritualism emerged as a practice of building connections in the gaps, delays and noise characteristic of emergent and unstable media.

Noise goes hand in hand with mobility, it lurks in channels, and thrives in transmission, it haunts any kind of communication. The technical problem of how to enable a message to emerge unscathed from transmission is the focus of cybernetic information theory. Claude Shannon's 1948 *Mathematical Theory of Communication* addresses the technical imperative of getting a message (including an image)

to survive intact through a noisy channel. Shannon was primarily concerned with how a message gets "*selected from a set* of possible messages" and how information can be retrieved or reconstructed from a message (or image) that has been altered by mediation, including through encoding and compression (Shannon and Weaver 1964, 31, his emphasis; Hayles 1987, 126).

Shannon insisted that the meaning of the message was irrelevant to the engineering problem of encoding and decoding information, yet his own examples reveal how false the separation is. His example of a text with low "redundancy" (meaning also low predictability) is James Joyce's modernist masterpiece *Finnegans Wake*. Texts like this prove a challenge to communication systems that rely on encoding and compression, since relatively little can be removed from the text without it being impossible to reconstruct at the other end.[11] In a high redundancy symbolic system—Shannon's example is that favorite of 1930s and 1940s proponents of language rationalization, C.K. Ogden's Basic English with its 850 word vocabulary—not only can the text be compressed, but in a noisy channel, "a sizable fraction of the letters can be received incorrectly and still reconstructed by the context" (Shannon and Weaver 1964, 75).[12] These examples are a give-away regarding the non-neutrality of what appears as principally a technical problem, since *Finnegans Wake*'s complexity as a text cannot be separated from its meaning, nor can Basic English's simplicity be separated from its ideological purpose. The formal and linguistic experimentation of Joyce's writing is part of the content of the text, while Basic English represents a different pole of modernism, one informed by logical positivism and the universal language and Unity of Science movements of the 1930s, and concerned with "debabelization"—the "purification, simplification and systematization" of language (Morris 1938, 81). Indeed, the 1949 introduction to Shannon's essay, written by Warren Weaver, connects information theory to universal language theories, arguing that Shannon's engineering theory should be used to inform the ways in which language is "designed" (Shannon and Weaver 1964, 27).

Geoghegan describes what Weaver was proposing as a "massive assimilation of the humanities, social sciences, and nature into a technocratic framework whose orderliness reflected the design of the machine systems from which it had been abstracted" (2012, 93). It is no surprise that these machine systems accommodate themselves more easily to the simplified and rationalized Basic English than to *Finnegans Wake*, despite Joyce's text more accurately representing the fate of language in the world of communication technology—as Donald Theall describes it, it is a "self-reflexive book about the role of the book in the electro-machinic world of the new technology" (Theall 1992, n.p.). While Shannon reads *Finnegans Wake* as difficult to disentangle from noise, a text that will not fare well in a noisy channel, it is also a text that mobilizes and anticipates noise as a central part of communication.

Shannon does not conceive of noise as a property of the original text but as a property of the channel (or the medium), and also as an outsider that invades the

system and perturbs or jams the signal during transmission. Examples of this from telecommunications include the noise generated in underwater cables by snapping shrimps, or the appearance of CMB in television "snow." Such intrusions seem to confirm a preexisting sense of a third presence between sender and receiver, which Michel Serres names the parasite (Serres 2007). Indeed, Serres argues that this "excluded middle term" is actually key to the functioning of media. For him, every channel once opened is opened up to interference, and media by definition must be "noisy." Serres argued that communication depends on "background noise, white noise, jamming, static, synchronic breaks" (Serres 1982, 40). Noise draws attention to the process of mediation itself; as Sybille Krämer writes, "only noise, dysfunction and disturbance make the medium itself noticeable" (Krämer 2015, 21). But also, and more radically, Serres viewed noise as the essential ground of mediation: "We see only because we see badly. It works only because it works badly. . . . I understand the message only because of the noise" (2007, 70).

The initial impact of cybernetics on the humanities was not at all what Weaver had in mind. In photography theory, it was used (albeit ironically) by Roland Barthes to challenge humanist theories of photography as a universal language.[13] Barthes argued that the press photograph's appearance of uncodedness reinforced a sense of its neutrality, and was made possible by the apparently irrelevant details of the real that cluttered the image (Barthes 1977, 27). If "noise" names the uninvited intruder that threatens the hierarchy and clarity of the message, the indiscriminate photograph is "noisy' even prior to any electromagnetic transmission. Barthes own "punctum" describes a kind of noise, an unintended detail, or incidental inclusion, that attracts the attention of a reader regardless of the intentions of the photographer (Barthes 1981).

Indeed, in photography, "noise" might describe a wide range of intrusions and interruptions in the image. As with radio and television antennae and the microwaves they pick up, light and photographic emulsion are highly sensitive to atmospheric interference, from water vapor, gases and visible light and other kinds of radiation. Photography is plagued with animal and plant interference too, from fungi in lenses, to flies and other creatures invading the darkroom. In a digital photograph, "noise" includes the artefacts resulting from compression, as in Steyerl's poor image. In a chemical photograph, it might describe the graininess of an image, which limits the amount it can be enlarged, or forms of contamination, corruption or interruption by outside entities. Such disruptions could include, for instance, the sulphurated hydrogen emissions from the Ilford gasworks that ruined 25,000 sensitized glass plates at the Ilford photographic factory on one day in 1899 (Catford n.d., 49–50). They might include the effects of extreme temperatures and moisture, but also of the beetles and lizards that invade the darkrooms of photographers in hot countries. Noise might even describe the people and animals that accidentally "photobomb" wedding portraits and holiday snapshots. Noise is part of

the appeal of chemical photography in a postdigital culture, hence the tendency of social media photo "filters" to mimic chemical flaws, including inconsistent grain, light leaks and contamination marks.

This noisiness is linked to the mechanical nature of photography, which, in the mid-nineteenth century, contributed to the sense that photography allowed the sun, or nature, to directly picture itself. In the early years of photography, a certain kind of noise also signified that time passed inexorably and could not be arrested. In a period characterized by growing anxieties about the loss of all fast-fixed certainties, religious and moral certainty was attached to the inevitability of decay and decline. To the natural theologists of 1830s and 1840s Scotland, for example, signs of material decay and traces of dirt and disorder that appeared incidentally in daguerreotypes supported the belief that the world would come to an end, and that it therefore began in an act of creation (Smith 1979; Morell 1971). Early photographic practice was informed by a Romantic aesthetic of the ruin: Louis Daguerre himself presaged his own invention with an 1824 photo-realistic painting of the ruins of Holyrood chapel (now in the Walker Art Gallery, Liverpool). John Ruskin was pleased to find that in his 1845 daguerreotypes of Venice "every chip of stone & stain is there" (Ruskin cited in Fawcett 1986, 187). Anxieties about decay, decomposition and environmental degradation motivated the times as much as a sense of rapid technical progress, and in this context, photographic "noise" appeared as a revelation, not of the past preserved, but of time passing and a world beyond the visible one.

## Shapeshifting

The question of how we characterize different photographic technologies has consequences for what we do with photographs, how we read them and what we exchange for them. It is unlikely that any history or theory of photography could dislodge our dogged attachment to photographic realism (especially in reportage and documentary photography), or our tendency to treat photographs nostalgically (especially in photographs of family and friends). More narrowly, however, the emphasis on the photograph as a frozen moment has led to a neglect of certain kinds of photographic technologies and practices, an overvaluing of others, and a narrow understanding of the myriad connections and disconnections between chemical and digital photography.

The history of photography, told as a series of transitions—from daguerreotype to the negative-positive processes, from wet plate to mass-produced dry plate, from unique print to half-tone reproduction and to wire photo, from analog to digital or wet to dry photography—seems to support arguments that photography moved from a messy physicality and objecthood to an increasingly virtual, imma-

terial state. Certainly, it may be true that photography is largely experienced (by the majority of photographers and their subjects) as a less materially demanding and more automated, fleeting and transient practice than it once was. It is also generally true that photography became technically faster—faster shutter speeds, more sensitive films, faster lenses—over the course of the twentieth century, a speeding-up that was driven by ideological, commercial and military imperatives, including a prior commitment to the modernity of the instantaneous. Cameras too have broadly become more transportable (when miniaturized in mobile phones for example).

Digital theorists have increasingly recognized the dependence of the "virtual" on material infrastructure, and the misleading nature of terms like "dematerialization."[14] Possibly, these were never intended to signify a literal loss of materiality, but rather to describe a shift from pictures experienced as solid and tangible to images that flicker before us and vanish again, that can be switched off, that proliferate and multiply. They capture how the digital image is variable and malleable, capable of innumerable temporary and potentially simultaneous instantiations, as against an analog image imagined as a stable print. However, I have suggested here that, the replacement in photography of chemical technologies with electronic technologies is not explicable in these terms. This story of a move from stable to unstable, fixed to fluid, material to virtual could even be inverted. We could instead describe liquid (wet, chemical) photography as constituted of environmentally hypersensitive, shapeshifting and alterable substances, its images held in suspension as only latent possibilities prior to the development of a film or the printing of a negative. Rather than regarding digital photography as existing in the realm of the virtual, we could emphasize its hardware, recognizing its dependence on a fairly solid set of technologies, a massive material infrastructure or an orderly and rigid pixel grid. That neither of these is sufficient demonstrates how reductive such oppositions of stasis and mobility, or materiality and virtuality, can be. Even so, I hope that our cultural attachment to linked narratives of technical acceleration and dematerialization might be challenged by the project of attending to the mobility and the fluidity of pre-digital photography.

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## Notes

1 This work was supported by the Arts and Humanities Research Council under grant AH/R014639/1.

2 Stiegler shares what Buse calls "the melancholic consensus" (Buse 2016, 28; Stiegler 2009, 18; Crogan 2010).

3 Notably Williams and Srnicek suggest that the dynamism of contemporary capitalist societies is fraudulent, but continue to regard the rapid exchanges of information involved in financial speculation as a model for a new kind of algorithmically planned economy, and continue to associate speed with futurity (Williams and Srnicek 2014, 358). As Michael Gardiner says, they envisage a "gleamingly turbocharged future" in which "capitalist infrastructures can be repurposed to emancipatory ends." Gardiner contrasts this with Bifo Berardi's less hubristic vision of a slowing down, a "postenergetic" society, linked to an ageing population (Gardiner 2017, 45 and 49; Berardi 2009, 21).

4 The dependence of ideas of media speed and instantaneity on the temporality and rhythms of the human body is evident in the writing of Paul Virilio, who sees photography increasing in sensitivity and speed in inverse proportion to the human eye (Virilio 1994, 13). For Virilio, not only does the speed associated with technical modernity outstrip that of the human body, it produces a slowing-down and desensitization of the body.

5 In Britain, as the archives of Boots the Chemist reveal, the "photography season" for retailers lasted from only April to September (Boots the Chemist, 1927, 438). Over the darker winter months, the photography department of the high street store had to transform itself into a diverse department selling lamps, torches, electric toasters and picture frames.

6 Far from being haphazard, liquid, chemical technologies are, as anyone who has visited a photographic film manufacturing plant may be able to attest, highly controlled and predictable. I am thinking of my own visit, in 2019, to the factory of Harman Technologies, producers of Ilford black and white films.

7 For Flusser, a technical image responds to a particulate reality, "something invisible that has blindly become visible" (Flusser 2011, 16). It is an image "brought forth by an apparatus" (Flusser 2000, 13).

8 As Stephen Jones explains, the concept of the digital refers to elements that are discrete and countable (on our fingers or digits), in contrast to the apparent continuity of much of what we perceive (Jones 2015, 87).

9 For example, in silver halide black and white photography, the surface area of the crystals affects the sensitivity of the emulsion and therefore the available shutter speed and aperture, and correspondingly, the speeds of moving objects that can be photographed. Thus, the seeming ability of the camera to slice time into ever finer moments (thousandths of a second) depends on the mechanical and optical qualities of the camera and lens, the amount of light available, but also on the gelatin, the film base, the sensitizing dyes used, and on a high degree of technical control over the size, shape, surface area and regularity of these grains of silver halide.

10 First identified by radio astronomers Arno Penzias and Robert Wilson, at Bell Telephone Laboratories (the research arm of AT&T and also the employer of Claude Shannon), CMB came to have a significant impact on cosmology, supporting the theory of the Big Bang over theories of a "steady-state" cosmos (Oliver 2019).

11 Shannon describes Finnegans Wake as a text high in relative entropy, where entropy measures the number of possible configurations or variables, or how much freedom there is within the system, and how much choice is possible. The higher the entropy, the more information (Shannon 1964).

12 Weaver explains that an increase in noise appears to be an increase in uncertainty, such that "if the uncertainty is increased, the information is increased, and this sounds as though the noise were beneficial!" (Shannon and Weaver 1964, 19). He goes on to make a distinction between types of uncertainty that Shannon does not explicitly make: "Uncertainty which arises by virtue of freedom of choice on the part of the sender is desirable uncertainty. Uncertainty which arises because of errors or because of the influence of noise is undesirable uncertainty" (Shannon and Weaver, 1964, 19; see also Hayles 1987, 119–42).

13 Barthes' cybernetically informed writings on photography, from the 1960s to the 1980s, are, as Bernard Geoghegan has argued, in many ways an ironic reworking of Shannon and Weaver's theories (Geoghegan 2011, 227).

14 See for example the work of writers such as Shannon Mattern, Lisa Parks, Jussi Parikka and Sy Taffel, among many others.

# 10. Moved by Rubens: The Double Logic of Image Perception in the Age of Mechanical Reproduction (1877–1977)

*Griet Bonne*

## Rubens' Trajectory

The Siegen born, Antwerp based and cosmopolitan Baroque painter Peter Paul Rubens (1577–1640) created an impressive oeuvre, in appearance as well as in quantity and geographical dispersion. His courtly and humanist education took him on semi-diplomatic missions to cities in Italy, Spain, France, England and The United Provinces of the Netherlands. During these missions, Rubens' brush formed his most powerful weapon of negotiation, resulting in an oeuvre distributed over the secular and religious palaces of seventeenth-century Europe. During his travels to Italy, Rubens extensively copied Renaissance masters such as Tintoretto, Michelangelo and Titian. This type of *referential reproducibility*, as Erika Balsom describes it (Balsom 2017, 4), was key to the development of Baroque art in the North and marked a new artistic vision, centered around (e)motion. But the Italian masters were inspirational on another level: Titian's collaborations with the Flemish engraver Cornelis Cort also provided the blueprint for Rubens' well-organized reproduction practice (Luijten 2004, 18–22), initiating a form of *circulatory reproducibility* directed towards multiplication and distribution (Balsom 2017, 5). It is this type of replication, and its impact on the perception of the original artworks, that will be the focus of this chapter. Peter Paul Rubens was one of the first Flemish masters to consciously engage with the reproducibility of his work, not only via multiple painted versions of a single composition, but also via prints produced and disseminated in his studio.

In 1618, the young and ambitious Lucas Vorsterman was the first of many craftsmen to be employed in Rubens' studio who successfully translated the pictorial qualities and subtle tonalities of the painted composition into a purely linear, black and white medium. Rubens consciously observed the impact of the graphic reproduction techniques on the original invention of the work and did not hesitate to change the composition according to the qualities of the printed medium (Hu-

venne 2004, 12). The collaboration between Vorsterman and Rubens ended in conflict in 1622 (Van Hout 2004b, 40–43). This is not surprising, taking into account Rubens' strict control over the end result. Rubens left little to the imagination and the artistic skills of the executor and maintained supervision over the quality of the reproductions by correcting every state of the plate until it reached a final version (Pohlen 1985, 141). Obtaining copyrights in both the Southern and Northern Netherlands as well as in France, Rubens was well aware of the commercial and legal conditions of mechanical reproductions. Through the distribution of his work via prints, he expanded its visibility, albeit changing its materiality and physical appearance thoroughly. The authorized institutions, such as the Catholic church and the Spanish government, quickly understood that the effectiveness of the work's monumentality could be substituted for an expanded visibility on a monumental scale (see Pohlen 1985, 170–173). Ever since, reproductions have operated within a socio-political framework. By the end of his life, Rubens' work was dispersed over the European continent, not only through commissions in the context of diplomatic missions, but also via prints that—besides serving his public relations— increased familiarity with the master's visual language (Van Hout 2004a, 30). Through graphic reproductions, Rubens' vast oeuvre took shape.

What Rubens set in motion with his reproduction practice was a *double logic of image perception*. Echoing Bruno Latour, the engravings after Rubens served as *immutable mobiles*: "objects which have the properties of being *mobile* but also *immutable*, *presentable*, *readable* and *combinable* with one another" (Latour 1986, 7). Through their remediation, reproductions initiate a centrifugal movement that spreads the artwork's image to a broader audience, simultaneously causing a centripetal force that enables us to see and approach these images as part of a comprehensive oeuvre. The double logic of image perception is hence a (western) socio-cultural mechanism that describes a mutual interplay between the trajectory of pictorial media and people. However, it was only by the end of the nineteenth century, with the advent of mechanical reproductions, that this mechanism of image perception became fully operative. Mechanical reproducibility initiated a whole series of technologies, resulting in the accumulation of new optical devices and pictorial media (centrifugal act), which radically shifted our perception of both present and past (centripetal response). In what follows I will examine this double dynamic, by comparing Rubens' 300$^{th}$ and 400$^{th}$ birthday celebrations, in 1877 and 1977 respectively. These two events formed a focal point in the *mobilization* of Rubens' oeuvre—by disseminating representational pictures and by modifying collective mental images—and demonstrate how the reciprocity of image and technology has *moved* people in modern society (Belting 2011, 15).

## The Centrifugal Movement

The centrifugal movement is first and foremost a technological movement, involving the accumulation of immutable pictures, which disperses the image of an artwork by remediating it (see Belting 2011; Latour 1986). In 1642, when Rubens' copyrights in France expired, many publishers and engravers already benefited from his fame to set up a lucrative print business (Van Hout 2004a, 38; Depauw and Van de Velde 2004, 8). However, the number of Rubens' reproductions suddenly grew exponentially in the 1870s. The festivities organized for his 300$^{th}$ birthday celebration had a significant impact on the quantitative expansion of reproductions, coinciding with a shift from graphic to photographic reproduction techniques (Fawcett 1986, 200–207). From this point onwards, pictorial media succeeded each other at an unseen pace, all of them resulting from three main technologies: photography, film and television. The impact of these modern technologies is best analyzed through their confrontation with prior modes of reproduction. Instead of focusing on technical innovations or legal requirements that made these technologies apt for reproduction purposes, I will concentrate on what Balsom described as *copy rites*: "extralegal social and historical conventions that shape the possibilities and meanings of image reproduction" (Balsom 2017, 8).

Since the birth of photography, its potential as a reproduction medium was recognized, but it was only around 1870 that the by then mass-produced photographs could successfully capture, without fading, oil paintings in full detail and all color shades (Fawcett 1986, 200–207). Compared to engravings, photographic representations were no more realistic nor objective in this early stage. Moreover, compared to the mechanically made photographs, the labor-intensive craftsmanship that was involved in the graphic process granted the engraving originality (Fawcett 1986, 202). Consequently, photography had to compete against its predecessor with another type of authenticity. By creating a relatively fast and cheap procedure, it exchanged an *auratic* feel for the promise of a *truthful* image. The objectivity granted to the photograph was related to the medium's social function, as Pierre Bourdieu explained:

> Photography did not simply appropriate one of the functions which had, until that point, been specific to engraving, the faithful reproduction of the real; leaving engraving with the task of illustrating fiction, it reinforced the pre-existing requirements of objectivity and realism by realizing them. (Bourdieu 1996, 74, note 1)

In fact, the photographic medium only "supplied the mechanical means for realizing the '*vision of the world*' invented several centuries earlier, with perspective" (Bourdieu 1996, 77, note 6). When both photography and engraving used the same conventions of perspective, the true difference of their impact lay not so much in their ability to consistently represent the original image, but rather in their *mo-*

*bility*: photography was not only cheaper and faster to produce, both its means of production and the product itself traveled more easily and, especially when its technology became adapted to the printing press, photomechanical pictures generated a visual testimony of cultures and allowed this to blend in with and hence define the inherently hybrid nature of modernity (Latour 1986, 7–10). Unlike the originals, we do not encounter photomechanical reproductions in isolation, separated from everyday life through monumental staircases and blinded windows. Mostly, photomechanical reproductions are offered to us as synoptic representations by print media (centripetal movement), which, as a newly established unity, can be distributed again (Latour 1986, 10). In the public press and in magazines, on postcards and posters, in art books and travel guides, "the meaning of an image is changed according to what one sees immediately beside it or what comes immediately after it" (Berger 2008, 29).

This potential was increased by the advent of the moving camera, which generated visual knowledge not only through the montage of various images, but also by decomposing a single image into close-ups. Through the camera eye, the gaze of the beholder is transformed simulating the contemplative attitude of moving closer and further away from an artwork to explore the surface from detail to detail. Meanwhile, the voice-over commentator could talk to the spectator while the camera led the eye. Consequently, the potential of the cinematic reproduction as a medium for art analysis was soon widely acknowledged among art historians, resulting in the foundation of the *Fédération Internationale du Film sur l'Art*. At its first conference held in Paris in 1948, chief conservator of paintings at the Louvre, René Huyghe, reported enthusiastically about the possibilities of the new medium after making one of the first art films in color, *Rubens et son temps* (1938): "People do not generally know how to look at pictures. The film enables us to hold the spectator's eye and guide it step by step through the descriptive and visual detail of a work of art" ("Summaries" 1948, 8). Also in 1948, art historian Paul Haesaerts and film director Henri Storck made *Rubens*, a film praised and criticized for its radical formalist approach and educational tone. Through its generous use of cinematographic techniques, *Rubens* became one of the main representatives of a new genre, instigating the discussion on whether the art film should be seen as a pure registration of art or if these films could claim artistic qualities themselves (Jacobs 2011, 3–4). Although film copies can be disseminated all over the world, the film medium did not affect the number of people that saw art through reproductions, so much as increasing the number of people that saw it simultaneously. For Walter Benjamin, this collective perception was key to generating an emancipatory, distracted reception of art in an everyday context, in contrast to the contemplation in the traditional experience of art (Benjamin 2008, 32–33). However, the architecture of the movie theater is designed to cut off reality and arouse individually lived experiences, rather than collective ones. In the dark of the movie theater the communal space dissolves into

the mental space of the individual (Belting 2011, 53). Subsequently, the immersive attractiveness of cinematic reproductions lies not so much in their *truthful* representation of the original image, but in the reproduction of a *genuine experience* of that image. Using the same mechanical device as photography, the newly generated pictures mobilize art differently because of their distinct physical appearance. Whereas photomechanical reproductions travel to us as a tactile object, cinematic reproductions are conveyed via projection in a darkened room:[1]

> The film medium does not consist of matter, the film on the reel; in order to become a medium, the film requires technological animation. In the viewer it creates the impression that the fleeting images flowing before his eyes are nothing other than his own images, like the ones he experiences in imagination and in dreams. (Belting 2011, 52)

Not only do cinematic reproductions—in contrast to the original to which they refer—appear as moving and ephemeral, the film medium accumulates images in time, rather than space. A photograph always depicts a crystalized moment that irreversibly belongs to the past. It is only through its mobilization in space that the photograph actualizes itself (Benjamin 2008, 13) and reaffirms its presence. Due to their technical animation, cinematic images, by contrast, seem to only appear in the now, and as projected images unravel, they leave no tactile trace for the viewer to hold on to.

Shown before feature films, short art documentaries became an important tool of the postwar cultural policy to educate and enlighten the people. But for the true massification of reproductions via documentaries, we had to wait for the advent of television in the 1950s and its ability to simultaneously disperse images in time and space. Like the cinematic medium, televised images succeed each other in time; i.e. real time, making them even more elusive than film. On the other hand, however, these images enter the social space of everyday life. They enter our private living rooms, simultaneously forming a segment in the large spatiotemporal continuity that is generated by the flow of images on our television screen, and which we have indicated synoptically as reality, i.e. truth. Especially in the early days of single channel television, the centrifugal movement reached its peak, when people did not watch television because of the items that were programmed, but because of the time at which they were programmed (Drot 1963, 19). By broadcasting art documentaries at a time when museums were closed, people could be reached that would not go to museums in the first place. And by showing them art in between other programs, the masses were familiarized with art during their everyday habits to a much greater extent than photomechanical or cinematic reproductions could previously achieve. Through television, fine art's most enigmatic images became part of a collective memory.

## The Centripetal Movement

The centripetal movement, directly related to the quantity and scope of the circulating reproductions, unfolds in two stages: Firstly, by comparing and collecting reproductions, similarities become apparent, converging in the master's unique style, which characterizes his *oeuvre* (cf. infra). Secondly, the conception of the oeuvre, the identification with a certain artist and the positioning of artworks within this oeuvre of that artist—early work, undeniable masterpiece, studio work, etc.—draws the attention back to the singular, *must-see* original.

Following Dean MacCannell's influential *The Tourist: A New Theory of the Leisure Class* (1976), the second stage has only been thoroughly realized through mechanical means and moreover requires certain social conditions that are emerging in a post-industrial society: "advanced urbanization, expanded literacy, generalized health care, rationalized work arrangements, geographical and economic mobility and the emergence of the nation-state as the most important socio-political unit" (MacCannell 1976, 7). These conditions generated a shift from labor to *leisure* as the defining element of social relations in modern society. MacCannell subsequently analyzes the tourist as an archetype of the leisure class and sightseeing as a modern ritual in a godless, instable and inauthentic society (1976, 5–16). It is the subject's lost connection to society that lies at the heart of an institutionalized value system concentrated on authentic experiences that center around the gaze (Balsom 2017, 28). Moderns travel to *sights* (Antwerp Cathedral), looking for *attractions* (Rubens' *The Descent from the Cross*) in search of authentic *experiences* (contemplating the masterpiece). The value of these experiences is directly related to the number of cultural *productions* (advertisement, exhibitions, art books, art documentaries, centennials) that are organized to coordinate the mechanism of sightseeing, by generating counter-images that enhance the authenticity of the attractions. It is clear that the centrifugal and centripetal mobilization of images and people in the age of mechanical reproduction is intensified during cultural productions such as the Rubens centennials. During these festivities, Rubens' legacy is transformed into a tourist attraction (MacCannell 1976, 1–44).

The 1877 celebration was one of the biggest and most influential cultural events of nineteenth-century Antwerp. International examples, such as the Michelangelo celebration in Florence (1875), must have inspired the ambitious plans for Rubens' anniversary. The program was designed as a superlative of the 1840 celebrations and combined folk festivities—which often had little to do with Rubens—with an art program, including a literary and an artistic academic congress, the inauguration of a new bust, the opening of the Plantin-Moretus Museum, an art historical competition to write the history of the Antwerp School, the ceremonial execution of Peter Benoit's pompous Rubens Cantata, and three art exhibitions. For the occasion, the city was decorated with a triumphal column and three arches echoing Rubens'

designs for the *Triumphal Entry of Cardinal Infante Ferdinand* (1635). On top of this, a historical parade marched through the streets of Antwerp, which was only one of the attempts to incorporate an art historical awareness into the Rubens Cult. Nevertheless, the hybrid character of the 1877 celebrations was received rather critically by the estimated 22,000 foreign visitors—most of them from neighboring countries. Especially the folk festivities and the prominent proliferation of Antwerp was reported to distract from the artist's achievements. Tellingly, the largest amount of the total budget of 378,000 francs was spent on the triumphal arches and the historical parade (Prims 1927, 207–214; Herwijn 1984, 249; Van Ruyssevelt 1977, 48–49).

However, the 1877 Rubens celebrations, and especially the *Congrès Artistique* organized by the Antwerp *Cercle Artistique Littéraire et Scientifique,* were significant for embracing the potential of mechanical reproductions (CALSA 1878, 468–469). In its ambitious invitation letter, we read a confidence in modernity as the only way to get to grips with the past:

> In this ardent melee, which marks our time in transition, we should ask ourselves whether it is not appropriate to establish our ties of affiliation with the past and, while claiming the glorious heritage of our ancestors, to let it be extensively permeated by the powerful breath of modern ideas.[2] (CALSA 1877)

It is therefore not surprising that photography played a crucial role in the debates during the three-days congress held in August 1877. Not only did photography invoke the need for copyright legislations, attendees also emphasized the importance of photography for the objective and systematic collection of sources and artworks. These ambitions resulted in the foundation of the *Codex Diplomaticus Rubenianus*, funded by the city of Antwerp and organized by a permanent committee, charged with assembling all publications and primary sources on the master, accompanied by reproduction photographs in case of discussion (CALSA 1878, 437–438). The ambitious plan marked the outset of the scientific study of Rubens (CALSA 1878, 381). From 1877 onwards, the appointed committee under the supervision of Max Rooses also started to systematically collect reproductions (prints and photographs) of Rubens' oeuvre. This collection was displayed for many years at the Royal Museum of Fine Arts in Antwerp and later, on the occasion of Rubens 350$^{th}$ anniversary, at the Royal Academy of Fine arts (Gedenkboek 1928, 18).

Although mechanical reproductions were explicitly present in the scientific part of the centennial, and were used as stand-ins for the originals in some of the exhibitions (cf. infra), the use of mechanical reproductions was not yet explicitly visible in the streets. The rather deficient advertisement of the events was limited to some (mostly imageless) posters and articles in the international press (Herwijn 1984, 248). During the festivities, the masses approached reproduction photographs much in the same way as they approached the originals. In 1877, mechanical reproductions mainly enhanced comprehensiveness in respect to the vastness

of Rubens' oeuvre, which led to a gradual development of the first stage of the centripetal movement. In the course of a hundred years—in which none of the commemorations would equal the efforts of the 1877 celebration—the second stage was elaborated to reach its apex during the 400th birthday celebrations.

The 1977 program again included some popular manifestations and festivities in the context of the Rubens year. These often-sensational events served as markers with which to highlight, by contrast, the "real" cultural attractions (MacCannell 1976, 14). Compared to the previous centennial, however, it was conceived far more as a yearlong art festival scattered around the city: concerts, theater plays, congresses and lectures, signalized walking tours, a sound and light installation, and no less than 17 exhibitions framed Rubens and his time. Among these exhibitions was the most ambitious Rubens exposition so far—and presumably ever—collecting over 160 paintings, oil sketches and drawings by the master in the Antwerp Museum of Fine Arts ("Programma" 1977). The coinciding of this exhibition with an academic colloquium and ten lectures organized by Unesco—that saw its ideal ambassador in the cosmopolitan diplomat (Detiège 1977, 25)—made Antwerp into a unique incentive for the study of Rubens (F.C. 1977). Never had there been so many experts, knowledge and, most importantly, art works assembled so close to the epicenter of Rubens' legacy: the artist's studio. Although Antwerp remained the main sight—with no opportunity left unused to emphasize the master's relation to "his" city—the festivities exceeded the local scale and substantial exhibitions on Rubens were organized in major museums in Paris, London, Vienna, Cologne, Leningrad, Florence, etc. ("Programma" 1977).

The Rubens Year did not only reach further in geographical terms, but also visually, by means of mechanical reproductions. In 1977, Rubens was encontournable. This did not remain unnoticed, as a self-conscious reflex could be distinguished in exhibitions such as *The Fame of Rubens*, investigating the Rubens Cult between 1640 and 1940, and *Rubens Now: A Concept or a Commodity?*, exploring Rubens' influence on contemporary artists and his appropriation within modern culture. Rubens and his work had never been more present in, and been part of, everyday life. Besides short reportages in cultural programs and news items, the Belgian television broadcaster (B.R.T.) made two educational documentaries with corresponding work books for primary and secondary schools. The documentary Rubens' *Life and Art* (12–15 years) was also screened in several exhibitions. Besides, the radio service published a series of 35 mm slides to be used in classrooms. The BBC and other foreign broadcasters followed B.R.T.'s lead, regularly reporting about the Antwerp celebrations and producing art documentaries for the occasion. Worldwide philatelic departments produced stamps with his self-portrait, aligning the *Prince of Flemish Art* with the Royals whom he once loyally served. Traveling exhibitions were organized using photographic reproductions mounted on adaptable panels (cf. infra). Every manifestation got its illustrated poster, and postcards with Rubens' most fa-

mous works from Antwerp were sold in all the souvenir shops, alongside Rubens beer, Rubens pie, Rubens medals, Rubens scarfs, etc. The Rubens celebrations of 1977 are a textbook example of what MacCannell calls the phases of sight sacralization (1976, 44–45): An artwork is labeled—and scientifically proven to be—a genuine Rubens (naming phase) and is therefore isolated through entrance tickets, booklets, captions, protective fences, guards, adapted lightning, etc. in order to enhance its experience, while providing optimal conservation (framing and elevation phase). Subsequently, the site of preservation is marked as an attraction in itself (enshrinement). The most important step in this process however, is the mechanical reproduction of the work:

> It is the mechanical reproduction phase of sacralization that is most responsible for setting the tourist in motion on his journey to find the true object. And he is not disappointed. Alongside the copies of it, it has to be The Real Thing. (MacCannell 1976, 45)

Mechanical reproductions hence serve as markers that—instead of desacralizing art works, as Benjamin suggested—constitute the *aura* of the original, by creating the desire to be as near as possible to the original picture of that reproduction (MacCannell 1976, 47–48). Boris Groys agrees with MacCannell, stating that the aura "emerges precisely at the very moment it is fading" (Groys 2008, 73). In other words, it is only because of its multiplication via copies that an original becomes unique. In an attempt to examine the place of the copy in our culture, Groys understands the difference between original and copy, therefore, as a topological question. The original acquires aura through its "fixed context, a well-defined place in space" whereas "reproduction means dislocation, deterritorialization; it transports artworks to networks of topologically indeterminable circulation" (Groys 2008, 73). The loss of aura that, according to Benjamin, defines the mechanical reproduction is hence the absence of this defined place, where the original is present. Herein lies the explanation for the commodification of mechanical reproductions: we buy mechanical reproductions because they represent the absent authentic experience. It is this absence of the *aura*—of a space (the place where the unique work resides) and time (the genuine moment of experience)—that makes us travel to the originals. Being cheap, mobile and collectable, Rolf Potts' examination of postcards forms an interesting case study to examine this topological dynamic. Bought as a *souvenir* of our authentic experiences, postcards also serve as indicators of what one should see while being on site. By sending postcards to our loved ones at home, we deliver proof of our experiences, as "the picture on the front of the card advertised the act of travel, and the postmark on the back certified it as authentic" (Potts 2018, 56–57). In the act of replication, however, the photomechanical picture does not show us the *lived* image[3] transferred to us in front of the original, but an idealized evenly lit version, which was taken from a neutral perspective. Not only does the postcard

fail to evoke what we have seen, it even comes to define this experience, by showing us how to approach the artwork and what to remember of it (Potts 2018, 56–57).[4] Serving both as markers and as reminiscences of the true originals, mechanical reproductions are the a priori and a posteriori medium of perception by which our authentic experience of the original is colored (cf. infra).

The commodification of mechanical reproductions is nothing but "a means of taking possession of the world and making sense of it" (Belting 2011, 145), or as Benjamin explained: "the desire of contemporary masses to bring things 'closer' spatially and humanly, which is just as ardent as their bent toward overcoming the uniqueness of every reality by accepting its reproduction" (Benjamin 1992, 669). Disregarding the ideological appropriation of this process, Benjamin underestimated the impact of manifestations such as the Rubens celebrations, organized by the governing authorities to structure these attempts at self-legitimation and thereby assure their central position within the modern world. According to Frans Baudouin, conservator of the Antwerp Museums of Fine Arts:

> . . . there are few things as modern as this Year. Now that humanity is discovering space and time, now that for the first time in history, African art and Borobudur can be integrated in our cultural canon, it would be short-sighted to ban our own history from this *musée imaginaire*.[5] (J.V.H. 1977)

## Rubens: A Portrait and a Map

Identifying a city with the name of the master, the fifth, *social reproduction* phase of sight sacralization (MacCannell 1976, 45), is one of the most important mechanisms of modern sightseeing and herein lies the political (ideological and economical) interest for cultural productions such as the Rubens centennials. It is to the *Rubens-city* that your reduced train tickets and package tours will take you ("Programma" 1977). It is the Rubens-city that produces all kinds of merchandize to take home as a souvenir (Van Spilbeeck 1877, 156; Bex, Raskin, and Van De Gehuchte 1977, preface). Subsequently, the city of Antwerp undergoes the same double logic of image perception as the artworks on its territory. The tourist gaze monumentalizes the city (Groys 2003, 189–193), which subsequently presents itself as an original—by reproducing its image in maps and skylines—and its inhabitants, *Sinjoren*, as the true ancestors of Rubens. Antwerp places itself in the artistic and intellectual legacy of the artist to legitimate itself as an important capital of art. Consequently, the nineteenth-century lack of evidence that Rubens was born in Antwerp remained a thorn in the flesh. Especially after Reinier C. Bakhuizen van den Brink published compromising evidence[6] in favor of Rubens' birthplace as Siegen rather than Antwerp or Cologne, the topic was the source of fiery debates (Van Ruyssevelt

1977, 47). It was not until 1903 that consensus was reached through Max Rooses' seminal *Rubens' Leven en Werken*, in which he proclaimed that, even though the evidence for Siegen was undeniable, this did not undermine the position of Antwerp as the only Rubens-city (Rooses 1903, 17). Already shortly after his death—spending most of his last years in Elewijt near Brussels—Rubens was framed as an eminent *Pictor Antverpiens* (Depauw and Van de Velde 2004, 8). Visualized through the recurrence of seventeenth-century city maps or Harrewijn's engravings of Rubens' house, the persistence in highlighting Rubens' connection to Antwerp becomes apparent in the Rubens centennials: In 1877, the Belgian photographer Joseph Maes was appointed to publish an album with 150 bound heliotype reproductions after engravings of *Portraits of the Most Prominent Antwerp Painters, Engravers, Sculptors and Architects of the Antwerp School since Quinten Massys* ("Album" 1877). The assignment for the art historical competition held in 1877 read *The History of the Antwerp Painters' School*. In 1977, every speech inaugurating an event still started and ended with a reflection on the connection between artist and city, with which the 738,000 visitors to the Rubens House that year eagerly agreed (F.C. 1977). However, if we consider his international career, both as a painter and as a diplomat, rooting Rubens in Antwerp is an overstatement, knowing that Rubens regarded "the whole world as his country" (Wittkower and Wittkower 1963, 97).

This cosmopolitan spirit of a humanist artist, intellectual, and diplomat thus perfectly suits *the myth of the artist* as cultivated by biographers and art historians since Vasari (Wittkower and Wittkower 1963, 93, 96). Along with the name comes an ideal, a brand, for which Rubens' self-portraits served as a trademark of quality (Bex, Raskin, and Van De Gehuchte 1977, preface). This constructed image of the artist is not only important in the light of the increasing democratization of art throughout the twentieth century, but is key to understanding the ideological recuperation of art and artists, for which cinema and especially television became the preeminent tools. The unbridled pathos displayed in Rubens' work stood in sharp contrast to the noble and unaffected, courteous gentleman he allegedly was during his diplomatic missions. It is especially the latter characteristic of the artist that is appropriated in a discourse on national—and in this case Flemish—identity. Whereas Rubens is internationally renowned for his qualities as a prominent Baroque painter, on a local scale, Rubens is promoted for his ambitious, diplomatic and reliable character. This so-called Flemish nature was also the basis for a costume drama on the artist: *Rubens: Painter and Diplomat* (1977) by Roland Verhavert, ordered by Belgian Television in the context of the 1977 Rubens celebrations. Although the series in five episodes was the first Belgian television production with international exposure, it was received critically in Belgium for its unpreceded production budget, mainly subsidized by the Flemish Ministry of Dutch Culture, and was highly controversial among art historians for its lack of focus on the artist's work. Frans Baudouin explicitly requested to be removed from the credits as an

advisor for the series. Almost none of his recommendations and remarks were considered for the sake of the series' dramatic value and the poetic freedom of screenwriter Hugo Claus (Baudouin, Van Raemdonck, and Vandenbussche, 1977). Although the television series gives us insights into how cinematic reproductions are used as tropes to highlight Rubens' genius and corresponding good manners, it did not succeed in reflecting the vastness and complexity of his oeuvre. This loss seems to be the reverse side of the medal of mechanical reproductions' democratizing power. In a television interview, the conservator of the Royal Institute for Cultural Heritage, Roger Marijnissen, expressed his concerns regarding the generalizations and popularizations in the course of the 1977 Rubens celebrations:

> I fear that the majority of the 700,000 visitors have come to look mainly at a symbol, and not so much at the work of one of the most important artists in the entire art history. . . . these are the professional objections that I have to bring against the entire manifestation. I do not know whether these are actually objections, they are only considerations, in order to put into perspective the euphoria surrounding the entire phenomenon. I fear that the cultural impact of such manifestations cannot be measured by the length of the rolls of entrance tickets that have been sold.[7] (Marijnissen 1977, 17'49" –18'49")

Marijnissen admits that the manifestations in 1977—and the many reproductions that circulated in their context—brought Rubens to the people, but he also notes that the *image* that was communicated through these events, postcards, tourist guides, commercials and posters might not always have done justice to the work itself. In fact, the only thing that had been conveyed to a wider audience was the very aura that Benjamin hoped to deconstruct through the use of mechanical reproductions.

It is not surprising that Rubens' self-portrait (ca. 1630) from the collection of the nearby Rubens House was omnipresent during the 1977 celebrations. The trajectory of reproductions—instigated by practical, technological, commercial and ideological considerations—clearly impacts *what* oeuvre is constructed. Shortly after the artist's death, the heart of his oeuvre—the most renowned and widespread images—had already shifted quite significantly from the oeuvre Rubens had compiled himself through the prints produced under his approval. While seventeenth and eighteenth-century prints after Rubens still depicted mainly religious scenes from the New Testament, the Rubens Cult quickly established a lucrative market by publishing reproductions of self-portraits and family scenes: works that covered only a minor part of Rubens' total oeuvre and were conceived in a private context, therefore very unlikely to be reproduced on a large scale by the artist himself (Depauw and Van de Velde 2004, 8–10). In a time span of 400 years, not much had changed in this respect. The images of the master and his family show an intimate, almost voyeuristic insight into the life of this enigmatic artist. At the end of

his life, *Rubens* was already more than the name of a talented painter or a peaceable diplomat. *Rubens* stood for an elusive totality, which let itself be explained only through the two icons that came to represent its aura: the portrait and the map.

Subsequently, Groys' and MacCannells' situation of the conception of the aura in the Modern Age, as a result of mechanical reproducibility, should be somewhat nuanced. Although the aura of the original unquestionably increases as more reproductions of it become available, it remains primarily *the myth of the artist* that produces its undeniable authenticity. Being confronted with a work by Rubens for the first time, a nametag is enough to *experience* the work's aura (and equivalent money value). In that sense, Benjamin does have a point when comparing the aura of an artwork with the unapproachability of a cult image (Benjamin 2008, 16). This is the result of an awareness, dating back to the Renaissance, that the picture not only presents an *absence* (that gains the original its aura) but also the absence of the gaze of its producer (which reinforces the aura). "An image became a record of how X had seen Y" (Berger 2008, 10). The original art work not only testifies to an authentic (as opposed to mechanical and standardized) creation, but also to "the figure of the artist as the 'personal example' of a life authentically lived" (Balsom 2017, 29).

## Mapping Rubens' Oeuvre

Until the nineteenth century, and in conjunction with a literary Rubens Cult, the study of Rubens' work remained mainly centered around Rubens' persona (Van Ruyssevelt 1977, 17). More than just a matter of a shift in taste, for a proper Rubens study to emerge, we had to await new visual technologies that allowed the development of Art History as a scientific discipline (Latour 1986, 13). By the end of the nineteenth century, photographic reproductions became a necessary requirement of connoisseurship, in order to compare works, separate them from their surrounding context and analyze them as part of a consistent oeuvre (Bohrer 2005, 247–249). It is in this desire for completeness—and the attractiveness of its impossibility—that the art historical groundwork on Rubens should be understood. Because of the quantity of his works, the international scope of his career and the numerous collaborations with renowned apprentices, collecting Rubens' work in one visual space seems an impossible task. Today, the most ambitious attempt at this is the ongoing project Corpus Rubenianum Ludwig Burchard. Initiated in the 1960s, this catalogue aims to collect and analyze all the artist's approximately 10,000 works by 2023.[8] However, in the course of history many more endeavors have been made, for which the 300$^{th}$ birthday celebration in 1877 proved an important catalyst. I have already pointed out the role of the Congrès Artistique, but in the exhibition in the Antwerp Museum of Fine Arts, photography was also used

for the sake of completeness. After some informal meetings with prominent European collections, it became clear that the plan to organize an exhibition assembling a representative part of Rubens' paintings—as already announced in the international press—seemed too ambitious (Herwijn 1984, 241). The plan was put aside, only to be successfully reconsidered for the 1977 celebrations. Instead, the Museum of Fine Arts decided to render a general overview of Rubens' oeuvre by combining drawings with reproductions and documents. *L'oeuvre de P.P. Rubens 1577–1877: Gravures, Photographies, Dessins, Documents, etc.* collected graphic reproductions from collections in Antwerp, Brussels and Haarlem, covering almost all the artist's paintings. The works for which no (satisfactory) print was found were represented by photographs.[9] Reproduction photographs were sent to the museum from numerous European collections, including photographs after Rubens' drawings. Some of the commissioned photographs could be purchased by the public via the concierge of the museum (Dupont 1877, 89). On multiple occasions, two engravings, or an engraving and a photograph, were compared; the differences between the juxtaposed images allowed a better understanding of the oeuvre (*L'œuvre*, viii–xi). This desire to collect artworks regardless of their location, material or size and the added values and meanings created by their comparison is a recurrent ambition that only became possible—so it seemed—in the age of mechanical reproduction.

During the preparations for the 1877 Rubens Year, another unaccomplished proposal expressed a similar confidence in modern media. Following the lead of prominent photo studios such as Adolphe Braun and Franz Hanfstaengl, Belgian photographer and publisher Joseph Maes launched the idea for a four-year reproduction tour throughout Europe to create an *encyclopedia* of Rubens' paintings. The journey would have resulted in a photo-exhibition of one thousand photo-autotypes of 18 to 20 cm width by 25 cm high, mounted on Chinese paper. As venue for this exhibition as part of the 1877 celebrations, Maes had Rubens' former house in mind, "to be acquired by the city, and [in order to] exhibit in his own home, the reproductions of the masterpieces, which his genius mind had dreamed of, which he gave birth to"[10] (Maes n.d.). The proposal was rejected by the central committee of the Rubens celebrations, presumably because of financial and practical objections (De Wael 1877). Not only was the estimated budget for the trip and equipment 12,500 francs, the governing authorities also had to take care of the required permissions (Maes n.d.).

In 1977, a similar yet converse idea for a photo-exhibition was launched. Similar in its attempt to generate a comprehensive overview of Rubens' work and his stylistic development, but whereas in 1877, Maes' intended to travel in order to bring Rubens' oeuvre to Antwerp, the city now organized a traveling photo-exhibition to take Rubens' works from Antwerp collections abroad (Stubbe 1978). The project was initiated in 1974, after contacting the Belgian photography company Agfa-Gevaert, which was conducting innovative research on realistic color technology.[11] The ex-

hibition existed in multiple editions, of full color and life-size reproductions of Rubens' work from public as well as private collections in Antwerp. If the size of the painting did not allow for a one-to-one reproduction, a full-size detail was taken and compared to a comprehensive reproduction in reduced size. Mounted on large panels, the exhibition was adaptable to different settings and could be dispersed to Belgian companies and cultural centers, or to smaller museums abroad. The stipulated aim of the project resonates perfectly with the double logic of image perception: on the one hand, it intended to bring Rubens to those places where his inventions could not be directly perceived (centrifugal movement), and on the other hand, the exhibition wanted to attract people to the *Rubens-city* (centripetal movement). With the help of the Ministry of Foreign Affairs and the Department of International Cultural Relations of the Ministry of Dutch Culture, international interest in the project was aroused. But again, financial considerations made many cities withdraw. As a result, the city of Antwerp bought two sets itself, one for educational purposes and one to exhibit as part of the educational exhibition in the Hessenhuis, which also screened the B.R.T. art documentary *Rubens' Life and Art*. One set circulated in France and a reduced one was ordered by the Ministry of Dutch Culture for circulation in cultural centers in Flanders. Other sets were sold to Belgian companies (DSA6 1977, 5–6).

The photo-exhibitions offer new insights into the mechanism of image perception. Not only do they mobilize a double logic as described above, they demonstrate how mechanical reproductions themselves become originals. According to Boris Groys, "we are not only able to produce a copy out of an original by a technique of reproduction but we also are able to produce an original out of a copy by a technique of topological relocation of this copy—that is, by a technique of installation" (Groys 2008, 73–74). The photo-exhibitions are essentially conceived as installations, *musées imaginaires* that offer genuine (in)sights into Rubens' praxis. Using state-of-the-art technology, Joseph Maes' proposal aimed to assemble a unique collection of high-quality photomechanical reproductions, and the original studio setting in which these pictures would have been shown was meant to confirm their authenticity. Similarly, the 1977 exhibition affirmed the quality of the large full-color pictures. Their materiality and size clearly contrasted with the variety of cheap reproductions disseminated in the context of the Rubens' celebrations. Groys' topological approach to Benjamin's aura-concept helps to clarify this difference: when the masses are moved toward the image, the image becomes authentic; when the image moves towards the masses, it identifies itself as a copy (Groys 2003, 37). In contrast to the disseminated reproductions in the streets, the images in the photo-exhibition were meant to be contemplated as originals. However, the 1977 photo-exhibition, which was conceived as a traveling format, positioned itself somewhere in between authentic installation and emancipatory copy, and this ambiguous status might have been the reason for its limited success.

## Moved by Rubens?

The 1877 and 1977 photo-exhibitions reveal yet another impact of mechanical reproductions: over the course of 100 years, not only had their trajectory shifted, the formal and material characteristics of the images had also changed quite significantly, from small-sized black and white reproductions to full color, one-to-one details. Accordingly, the relationship between original and reproduction had altered, not only through evolving social structures and by a repeatedly nourished Rubens Cult, but also through the images' transformed physical presence. Subsequently, the centrifugal movement of mechanical reproductions not only brought us to the authentic originals, now they had become the reference point to approach these originals. A review of the 1977 traveling exhibition in the French newspapers is revealing:

> What is curious is that the works, reduced in their dimensions, appears to me more readable, the eye embracing the whole composition better than while in front of the originals. I remember having admired the works in Antwerp Cathedral, but with a sense of being overwhelmed by their dimensions, which felt like an obstacle to grasping the unity of the composition.[12] (Baudouin 1977, 28)

Apparently by 1977, an intelligible reproduction, in a familiar, modern medium, is favored over the dazzling, monumental comprehensiveness of the original. One could aptly ask, then, are we still truly moved by Rubens? In our search for the true image of Rubens, we all too easily disregard the medium-specific features of the mechanical reproduction through which this image is transmitted. Hans Belting rightfully observes that "we are more familiar with the medium, the means of transmission than we are with the images that are transmitted. In fact in order to believe images, we require that they come to us through familiar, accepted media" (Belting 2011, 20). What we look for in the original and what we remember from this experience is highly influenced by its modern mediation of mechanical reproduction, its technological development as well as its variable functions within different reproduction media (e.g. art book, poster, news item, etc.) that overwhelm us every day. From a technological point of view, the formal characteristics of mechanical reproductions developed not only in relation to the originals, but also in the interplay between different reproduction media.

Throughout the twentieth century, technological developments evolved towards more *realistic*, *accurate* and *truthful* representations, in terms of detail, color and appearance. However, the unavoidable variations in color, surface and scale, the altered physical presence, the absence of the frame as of the surrounding walls, and the different perspective of the beholder affect our perception (Savedoff 2000, 160–165). Moreover, mechanical reproductions are implemented in various reproduction media themselves, each using their own medium-specific visual strategies

(i.e. isolation, succession, juxtaposition), which, often unconsciously, influence our perception. Especially the development of the *Film sur l'Art* genre in the 1940s and 1950s reshaped our perception. Through the artistic gesture of *montage*, a still image was set into motion (Malraux 1947, 111–113). Rubens' motionless representation of movement inspired directors to transpose his work to the cinematic medium. Its compositional clarity proved a conductive guideline for camera movements. By decomposing the image cinematographically into close-ups, tracking and panning shots, filmmakers such as Henri Storck and Charles Dekeukeleire often showed striking comparisons between the everyday, volatile reality and Rubens' vibrant creations. Through this moving, hypermediated frame, Rubens entered the living room in the 1950s. The broadcasted reproductions on television evolved even further away from the original, due to their small size and the relatively low quality of the television screen, which made longer shots of close-ups better suited to the medium (Drot 1963, 8). Subsequently, photographic and photomechanical reproductions, as a reaction to the moving image, increasingly evolved according to this new vision of Rubens' images, of which the 1977 photo-exhibition is exemplary. While claiming a certain transparency and objectivity by offering full-size reproductions, the use of details implies a reframing of the work and hence the loss of its inherent harmony.

Consequently, between 1877 and 1977, mechanical reproductions brought us both closer to and further away from the original perception of Rubens' oeuvre. The centennials converged Rubens' images—both reproductions and originals, even directly combined in the exhibition space—in one city, and at the same time dispersed his *remediated image*—both the oeuvre and persona—on a global scale. This is the double logic of image perception in modern society: a continual reciprocity of images and people, which mobilizes our reception of art.

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## Notes

1 Slide shows, which introduced photography to the university lecture halls as from the 1880s (Bohrer 2005, 249–250), should be positioned somewhat in between photomechanical reproductions and cinematic reproductions. While appearing to the beholder in an ephemeral format and succeeding each other in time—without the possibility of the beholder looking back at will—the images remain still and therefore ask for a more active attitude of the beholders' gaze.

2 "Dans cette mêlée ardente qui marque notre époque de transition, nous nous sommes demandé s'il ne convenait pas d'établir nos liens de filiation avec le passé et, tout en revendiquant le glorieux héritage de nos ancêtres, d'y laisser pénétrer largement le souffle puissant des idées modernes." Translated by the author.

3 According to Belting's Anthropology of Images, images travel from objects in the physical world to our bodies and back, merging in our minds with other images, which can be both personal and collective. The image that I see in the original is different from what you see, as we both have a different (biologically determined) sight and different (psychologically and culturally defined) in-sights. Therefore, one could argue that there is no such thing as the image, but rather infinite copies of an image, multiplied by every gaze. It is my observation that by detaching the image from its singular medium (the painting) and incorporating it into a multipliable medium, Benjamin aimed at liberating the image's inherent plurality, which was restricted by its aura. The process of de-auratisation should then be understood as an attempt to shift emphasis from the production of images (the genuine master's hand) to their percep-

tion (the most elementary function of the picture). "Technical reproducibility, which Walter Benjamin once distinguished from museum presence, was merely the first phase in this process. Technological images have shifted the relationship between artifact and imagination in favor of imagination, creating fluid transitions for the free play of the mental images of their beholders, at least in terms of their perception. And perception has changed as well, both in general terms and in the specific sense of the way in which images are experienced" (Belting 2011, 41).

4 It is not surprising, then, that amateur photographs taken by tourists are complimented for their resemblance to postcard photography.

5 ". . . dat weinig dingen zo modern zijn als dit Jaar. Nu de mens bezig is de ruimte en de tijd te veroveren, nu wij voor het eerst in de geschiedenis negerkunst en borobudur in ons kultuurpatroon kunnen integreren, getuigt het van een eng denken het eigen verleden uit dat 'musée imaginaire' te bannen." Translated by the author. In the English translation the denigrating term 'negerkunst' is replaced by the author to 'African art.' Frans Baudouin was involved in the organization of the Rubens' celebrations, and made this remark in a lecture considering the criticism of the Rubens Year.

6 Fearing Alva's reign of terror, Jan Rubens fled to Cologne because of his sympathies for the insurgents during the Eighty Years' War. In Cologne, he met Ann van Saksen, the wife of Willem van Oranje, and became her lawyer, assistant and lover. When the adultery came to light, Jan Rubens was imprisoned and later banned to Siegen, where four years later Peter Paul Rubens was born (Rooses 1903, 2–11).

7 "Ik vrees dat een groot deel van de 700 000 bezoekers vooral naar een symbool komen kijken zijn en niet zozeer naar het werk van één van de belangrijkste kunstenaars uit de hele kunstgeschiedenis. . . . dat zijn samengevat de professionele bezwaren die ik tegen de gehele onderneming in te brengen heb. Ik weet niet of dat eigenlijk bezwaren zijn, het zijn alleen consideraties, waarbij gepoogd wordt de euforie die men aan het gehele fenomeen overgehouden heeft, om dat even te relativeren als dat kan. Ik vrees namelijk dat de culturele impact van dergelijke manifestaties niet af te meten is aan de lengte van de rollen entreebiljetten die men verkocht heeft." Translated by the author.

8 A large number of the published volumes can be consulted digitally via the website: https://www.rubenianum.be/en/content/corpus-rubenianum-ludwig-burchard (accessed 5 May 2020).

9 While books and journals since the turn of the century favored photography over engravings, in general, exhibitions persistently preferred engravings that were believed to be originals in their own right. Herein we can observe the different agencies of both reproduction media, and their corresponding function as an auratic art object or a truthful representation.

10 ". . . à acquérir par la ville, et exhiber dans sa demeure même, les reproductions des chefs-d'œuvre, que son génie y a rêvés, y a enfantés." Translated by the author.

11 Although the technology for color reproductions had been developed already by the turn of the century, it remained a highly subjective and hence expensive procedure of dubious quality. Apart from publishers, such as Phaidon and Skira, who made it their trademark, the common use of color images in art books only slowly took off after the Second World War.

12 "Ce qui est curieux, c'est que les œuvres, réduites dans leurs dimensions, me sont apparues d'une lecture plus facile, l'œil embrasse mieux l'ensemble de la composition qu'en face des originaux. Je me souviens avoir admiré les œuvres de la cathédrale d'Anvers, mais avec le sentiment d'être écrasé par leur dimensions qui étaient un obstacle pour saisir l'unité de la composition." Translated by the author.

# 11. Follow the Films. Reuses of a Research Film: Biography, Recycling, Whitewashing, Appropriation and Palimpsesting

*Mario Schulze and Sarine Waltenspül*

## Introduction

In 2009, the city of Göttingen installed a plaque commemorating the achievements of the engineer and physicist Ludwig Prandtl. For a town that promotes itself as a "city that creates knowledge," it is—in times of tourist marketing—an obvious means to tag the city map with the biographies of important scientists. More noteworthy is that at the same time, the daily newspaper *Göttinger Tageblatt* published a DVD with two films that Prandtl made between 1927 and 1933. Scientists' biographies abound (there is also a good one about Prandtl, Eckert 2017), but the 'life' and 'afterlife' of scientific films has so far been largely unexplored. As this article will elaborate, it was neither the first nor the last reuse of this particular film, nor are the manifold reuses of (scientific) films a singular case. We believe that it is key for the understanding of scientific films to follow their reuses, their circulations, their recyclings, their appropriations and their trajectories, or in short and based on the methodological catchphrase of the Actor-Network-Theory (ANT): to *follow the films!* (Latour 2005, 12, 237)[1]

Until recently, scientific films have escaped the attention of academic research. Film studies were, until 20 years ago, almost exclusively interested in feature films or art films (Hediger 2005). In Science Studies, it was often only mentioned in a side note that scientists had also produced and worked with cinematography or more recently with video. Although there is extensive literature on the role of the visual in the sciences (Hentschel 2014), the vast history of scientific filmmaking is still mostly unknown. The existing studies focus primarily on films from biology (Landecker 2006; Schultz-Figueroa 2018) and medical sciences (Cartwright 1995; Schmidt 2002; Olszynko-Gryn and Ellis 2017) and are devoted almost exclusively to the period before the First World War (Canales 2009; Curtis 2015). The role of films in popularizing science (Boon 2008; Gaycken 2015), in teaching (Alexander 2010;

Orgeron, Orgeron, and Streible 2012), or in sex education (Laukötter 2019) has also been considered.

Despite these relevant studies over the past 20 years, there is still a striking lack of literature on the following questions: How were scientific films produced in the laboratory, but also and even more so, how, why and when did they leave the laboratory, and if so, how were they distributed, instrumentalized, handled and reused outside the laboratory (Hediger 2005; Zimmermann 2011)? How did they eventually become part of teaching films, science communication films, experimental art films, feature films, etc.? And also, how have scientific films been archived (Ziehe and Nägele 2013)? Answering these questions and developing an understanding of the function of films in the sciences might help to clarify basic (mis)understandings on the side of the scientists working with film and on the side of the audiences confronted with film as instruction, evidence or truth.

In order to approach the history of scientific films, we suggest following them from the first attempts at their production and evaluation to their repeated reuse in different scientific disciplines and broader contexts in order to better understand the multiple and subtle intertwinements between science, politics and the public sphere. By pointing out the range of variations that the same material can cycle throughout history, our aim is to better map the aesthetic, intermedial and cultural transformations associated with the constant 'reuse' and 'recycling practices' of film material. We want to show that scientific films cannot be fully understood at just one point in their existence but rather through their processes and ongoing analog as well as digital (re)cyclings (Sattelmacher, Schulze, and Waltenspül 2021).

In the interest of clarity and brevity, we will focus on only one example: a flow film called *Entstehung von Wirbeln bei Wasserströmungen* (Production of Vortices by Bodies Travelling in Water) by Prandtl and his doctoral students Oskar Tietjens and W. Müller, which focuses on basic research questions in fluid dynamics (Fig. 11.1). This film has had an eventful history spanning almost 100 years. It serves us to discuss the ways in which films circulate through space and time—in their changing materiality (from 35 mm nitro film to 16 mm safety film to different file formats) and visuality (from a rough cut to reedited found footage to digitally color-graded and noise-reduced) as well as their shifting epistemic functions (between measurement, research, teaching and popularization).

To approach knowledge circulations through this scientific film, we will draw, on the one hand, upon the literature about the circulation of things and their entanglement with knowledge (Bauche and Vogel 2016; Gugerli et al. 2011; etc.) while considering, on the other hand, the medium specificity of film; since film is not only a material object (as film reels, strips or celluloid) but also and foremost, a moving image when screened. Film is also tied to editing and narrativization. We will start our story of Prandtl's flow film with the idea of transferring the "object biography" to research film, because it is one of the most prominent concepts to

describe shifts of identity, value, meaning or materiality that occur when things are moving through time and space. By pointing out the strengths and weaknesses of the biography approach, namely its anthropomorphic connotations and the linear path of development it implies, we afterwards suggest writing the further history of the film by its constant reuses through different institutions and persons. As has been thematized in the literature on art films, a wide array of recycling practices has been constitutive in the history of film (Blümlinger 2009; Jutz 2010). We are going to show that procedures between experimental montage, found footage appropriation and format transfers are common, not only in contemporary video art but throughout the history of scientific film. In a close reading of the film's history we suggest expanding that repertoire of possible reusages of film material even more.

## Film Biography: From the Laboratory into the World

Ludwig Prandtl experimented with film since 1912 (Prandtl 1912/1961, 1267). Especially after the early 1920s, he and his doctoral students spent a lot of energy trying to extract measurements from celluloid. They even redesigned their amateur cinematograph to create a hybrid between photo and film camera (Schulze and Waltenspül 2019). If we were interested in the progress of theories and measurement technology, we would have to reason that by and large Prandtl's experiments with film failed. But following the trajectories of Prandtl's "cinematographic desires" (Canales 2011, 330) allows for a different narrative. After years of experimenting, he changed his strategy and produced a film for demonstration purposes, namely for one special event: The Wilbur Wright Memorial Lecture held at the Royal Aeronautical Society in London in 1927 (Fig. 11.1a) (Prandtl 1927a/1961, 1545; Prandtl 1927b/1961). The lecture and the associated prize were a big success. This was proof that Prandtl's theories were recognized abroad (after their long rejection, Bloor 2011) and that he had become the most acknowledged flow researcher of that time (Eckert 2017, 164–169). For Prandtl, the film was a welcome means of visually illustrating, conveying and underpinning the central ideas of his boundary layer theory and therefore the successes of his career—especially given his poor knowledge of English at the time. Just like people who surround themselves with personal things to develop their personality and reflect on it, Prandtl used the film as part of a narrative process of self-defining his career.

Although the idea that not only persons but also 'inanimate' objects might have a life to be told can be traced throughout Western and particularly Non-Western cultural history, the idea is usually credited to social anthropologists Arjun Appadurai and Igor Kopytoff claiming that the (de)commodification processes of things can be viewed biographically (Appadurai 1986; Kopytoff 1986).


Figure 11.1: Different verisons of the Göttingen flow film from 1927 to 2009

Subsequently, the concept was expanded to other media and to knowledge circulation: e.g. scientific images (Hagner, Mazzolini, and Pogliano 2009), data (Peled 2014, 107), scientific concepts (Daston 2000), cities (Arnold 2002) or media events (Lash and Lury 2007). As far as we know, the only application of the concept to film comes from the theologian Dwight Friesen (2018), who analyzed how biblical films function in the daily lives of Christians.

One central idea of Kopytoff, who coined the term "biography of things," and his followers is that the life cycle of a thing is often tied to the biography of a per-

son (Kopytoff 1986). Tracing the transfers of ownership, i.e. who is allowed to have it, to borrow it or to use it, and tracing its journey from production to its loss or disposal is a way to gain insights into the lives, status or living conditions of the people linked to the thing. The insight that the histories of things and the histories of people are difficult to separate can also be applied to scientific films and our example: indeed, Ludwig Prandtl and the film he produced became intertwined. Following Kopytoff by asking questions similar to those one would ask about people, it becomes not only evident that a scientific film can assume different functions and meanings but also—following later adoptions of the object biography concept (Hoskins 2006)—that this particular film had an effect on the biography of its maker(s). Adopting the perspective of an object biography leads to central questions: Where does the film come from? Who made it, under what conditions and for what purpose? What has its 'career' been afterwards, and what did its makers consider as its ideal 'career'? How did it travel through time and space?

Prandtl was known mainly for his airfoil theory and his boundary layer theory, which he developed in a seminal paper in 1904/05 (Prandtl 1905). However, he never managed to find a general mathematical description of the boundary layer separation behind cylinders and other pivotal objects in aerodynamics, like airfoils or bluff bodies. Therefore, he used film as a way of showing and demonstrating the vortices caused by boundary layer separation. That is remarkable, given the fact that visualizations often had a precarious role in fluid dynamics, and that they were usually subordinated to mathematical descriptions (Bloor 2008). But following up on his lecture in London, Prandtl began to frame the film increasingly as a kind of visual evidence. He even used it as an argument in written discussions. In 1928, he wrote in a response to his opponent Friedrich Ahlborn, with whom he was in a dispute about the theory *and* about the film itself: "For what follows now, there is no actual theory, but a qualitative doctrine proven by the visual material but not explainable by the exact language of the formula"[2] (Ahlborn 1928, 184). As a consequence of the mathematically insolvable vortex formation, visuality seemed to have gained relevance over numbers.

If the medium of film had disappointed Prandtl's hopes two years earlier, the film he finally produced became part of his theory, at least to a certain extent. This underlines what Lisa Cartwright raised in response to the concerns expressed by Bruno Latour, Ian Hacking or Michael Lynch about the visual in Science Studies, namely that the visual may often be a dead end, and it may have misled scientists time and again, but from this it cannot be concluded that the visual is valued too highly: "To dismiss the visual as overrated is to overlook the role of pleasure as an important factor in scientific process" (Cartwright 2014, 251). Using the notion of biography in the context of scientific films can provide new perspectives and questions about how scientists are involved with the visual material they produce and distribute. Film biographies, therefore, might help in the shifts from studying

the life of the (white male) scientist, through his papers and theories, to studying the scientist's practices of conveying, of creating credibility and providing authority to the reception of his work.

As visual evidence, the film began to travel: in 1929, Prandtl took it along on his around-the-world trip and showed it at several research institutes in Moscow, Tokyo, Kobe, Stanford, Pasadena, Urbana Il, Ann Arbor MI, Detroit, Pittsburgh, Washington DC and Boston.[3] Prandtl's trip was also a kind of 'tour' adding to his fame and his theories. On this tour, the film was always with him—at least until it was stolen on the platform of Detroit train station. But even if colleagues reassured him that his lectures would be very interesting even without the film, Prandtl secured a new copy of it from his former assistant Tietjens, with whom he had made the film and who was at that point—what a coincidence—employed in Pittsburgh. In other words, the film not only took part in consolidating Prandtl's influence on the emerging field of fluid dynamics, it had also become an indispensable companion for Prandtl. Prandtl himself seems to have become a "showman," as Tom Gunning called exhibitors of early films and film shows, attracting the audience by the act of showing moving images and supplementing them with other show elements (Gunning 1997).

The early history of Prandtl's film shows that the concept of the object biography can also help understanding the circulation and transfer of scientific knowledge through film. Congruent to the insights that Samuel Alberti highlighted with regard to object biographies, film biographies can offer a "narrative hook" for telling the history of knowledge circulation, they can embed the study of scientific practice in visual culture, and they can be "a prism through which to view various publics' experience of science" (Alberti 2005, 560). Furthermore, by bringing the scientists' individual desires and biographical path dependencies into focus, they can help us to understand the often-implicit conditions of the circulation of scientific ideas—especially when we read the biography of the film together with the biography of its beholder.

However, the application of the notion of biography to objects has been criticized (Hahn 2015) and it also needs to be scrutinized in relation to film. Mainly, two points of criticism are pivotal: anthropomorphism and linearity. Firstly, the forms of existence of material objects and also of film reels contradict the laws of life cycles. There is no birth and death, emergence and transience, no clear definition of beginning and end. What would a rediscovered film copy—like *Metropolis* in 2008—be: a zombie? In order to avoid this critique, the terms "trajectory" (Rheinberger 2000) and "itinerary" (Hahn and Weis 2013) have been proposed. But they do not escape the second point of criticism, which regards the linear and singular path of development that a biography and, even more so, a trajectory insinuates. The film can be replaced by another copy. Although one material film reel is anchored like its owner in a particular space and time, the film can be everywhere

and nowhere due to its reproducibility. Furthermore, as a reproducible object, the film is not used up as are most everyday commodities (such as food, clothing, etc.). Scientific films in particular are often entities in-between material objects and endlessly reproduced visuals. Often, they exist as only one or a few copies. And as the first episode in the history of the Göttingen flow film shows, they can assume a kind of unity with their owners as long as they stay close to them, and they can be formative for their owners' identity. Therefore, the biography concept should not be given up too hastily but rather be critically examined and expanded. Because when it comes to the circulation of films beyond the scientist's sphere of influence, there might be other useful approaches that do not fall into the traps of implying one singular path in circulation and of anthropomorphizing the film. In order to write the history of this film and broaden the concept of object biography, we suggest looking at the specific and often singular practices of reusing the film: recycling, whitewashing, appropriating, remembrance and palimpsesting.

## Recycling: Raw Materials for Nazification

The subsequent history of the film shows how the biography of the film and the biography of its author started to diverge. In the 1930s, the film entered the Reich Office for Teaching Films (*Reichsstelle für den Unterrichtsfilm*, RfdU, later called Reich Institute for Film and Images in Science and the Classroom, *Reichsanstalt für Film und Bild in Wissenschaft und Unterricht*, RWU), founded in 1934 as a branch of the Reich Ministry of Science, Education and Culture (*Reichsministerium für Wissenschaft, Erziehung und Volksbildung*, REM), which aimed to unite and standardize the education system in Nazi Germany. As the film theorist Yvonne Zimmermann states "[b]y removing useful films from their original context, they . . . are placed in a new addressing context" (2011, 133).[4] This change of the addressing context was not only accompanied by a change in the function of the film—from a research and lecture film to an instructive and educational film—but also to an increase of the numbers of its copies and its radius of distribution. Because of this, the previously suggested concept of biography is no longer suitable for interpreting these episodes and needs to be expanded. By framing this episode as a recycling, in the sense that is used in today's everyday language, we hope to emphasize the economic and political relevance of films in circulation beyond their original context. 'Recycling' is discussed virulently in the literature on circular economy (i.e. Sillanpää and Nicibi 2019), as opposed to a linear economy with its take, make, dispose strategy, discarding material that is still valuable. Within a circular economy, recycling describes the process of converting waste into something new by breaking it down into raw materials.

The following episode is about the history of Prandtl's flow film in the 1930s: How did it find its way into the distribution system of the RfdU, how was it massively reproduced? How was it commodified in what was perhaps the first and biggest educational program mainly based on film as its pivotal medium: the National Socialist Gleichschaltung?

Even though the idea of using film as an educational tool is much older than the National Socialist ideal of *Gleichschaltung*, a project on the scale of the RfdU only became possible by overcoming financial, organizational and technical difficulties first (Tolle 1961, 10–17). With the introduction of the so-called contribution to learning resources (*Lernmittelbeitrag*) and of 16 mm acetate safety film instead of the easily inflammable and toxic nitrocellulose film, the basis for forcible coordination was set. And, as stated in the founding decree of the RfdU, film, being one of the "most relevant aid[s] in teaching," could be "put at the service" of the National Socialist "worldview" (Rust 1934, 24).

In 1935, the unification of the German education system was expanded to include research and teaching in higher education. The new university department (*Hochschulabteilung*) was financed by students with 1 Reichsmark (R.M.) per semester, the same amount as the learning aid contribution *Lernmittelbeitrag* for school children.[5] The department contacted Prandtl that same year. By pointing to the "common goal" of serving German research and the education of young scientists, they asked him that "this working copy, which contains individual negative sequences in random order, should be cut and transformed into a meaningful version. As far as possible, this version should already meet the requirements of university teaching."[6] Prandtl himself put in great efforts to do so. He changed the intertitles, the sequences and their order; he cut the film, with a seemingly satisfying result.[7] The RfdU called the form of the title and the repetition of the sequences "exceptionally valuable from the standpoint of teaching methods."[8]

In 1936, the RfdU finally published the film in two parts as "C1" and "C2" with an accompanying text by Prandtl (Fig. 11.1b). C stands for university film (*Hochschulfilm*) and the number one signifies that Prandtl's film was the first in the media catalogue and rental system of the university department at the RfdU (RfdU 1936, 24). The fact that they were nationally and internationally famous is reflected by the number of ordered copies.[9] Thus, in cooperation with the RfdU, Prandtl transformed the research film that he showed at conferences (with a primary epistemic function) into an educational film for technical universities (with an instructive function).

In the case of C1, a film from a research context was recycled to become an educational film. Although this reuse implies a certain predictability, this episode shows likewise that the "trajectories" of the film are not as clearly foreseeable as the ballistic term trajectories implies. Prandtl's version of the flow film was not only shown at conferences by its creator, and the recycled RfdU version was not only

multiplied and shown in lecture halls. Its entrance into the distribution system and the increasing commodification of the film also allowed its parallel and multiplied uses in new contexts: the film became an object of political negotiations and of military interests.

Remarkably, in 1936, the history of the film C1 and the history of the later Institute for the Scientific Film (IWF Göttingen) crossed for the first time: Gotthard Wolf, an employee of the RfdU, contacted Prandtl. Wolf later founded the IWF and the Encyclopedia Cinematographica, and therefore became a key figure in the field of scientific films in Germany and beyond. Before the war, Wolf asked for Prandtl's advice concerning "basic clarification" about the delivery of films to "private institutions." He mentioned an order of C1 by the Heinkel aircraft manufacturing company, which was the biggest producer of airplanes in the first half of the 20th century and which worked for the German Army Ordnance Office (*Heereswaffenamt*) after 1935. Wolf also writes that orders had accumulated in the past and even though a decree by the Minister of REM, Bernhard Rust, only permitted the delivery to universities and their institutes, he was counting on Prandtl's opinion. Prandtl replied that he was not requesting a special arrangement, but that he wanted to be informed of the Minister's decisions. The special decree to deliver the RfdU films to ministerial and half-ministerial institutions as well followed shortly after.[10] It could therefore be concluded that not only the contexts shaped the film, but that the film might also have formed such contexts as the RfdU. Basic research on fluid dynamics—like the visualization of the boundary layer theory in Prandtl's film—provided valuable information for aerodynamic applications and these were definitely not restricted to classrooms.

This episode from the 1930s provides at least two insights for a better understanding of the movements of scientific films. The first is related to the medium specificity of film: Due to the opportunity to change the material structure of a film, to recut and revise it, a recycling of previously existing material for new purposes becomes feasible. For a National Socialist institution such as the RfdU, this even made it possible to recycle—or from their standpoint even upcycle and valorize—the film for the intended unification of the education system in Nazi Germany. The second insight is rather time specific: It was not until the 1930s that an institution of the scale and range of the RfdU became operable. Even though Prandtl had already made a few copies of the film reel himself (using them as a gift or taking them along on his world tour for screenings), the high numbers of copies and especially their distribution on a large scale only became possible through 16 mm safety film and the specialized structure of the RfdU. This in turn led to a new mobility of scientific films. The increased numbers of copies could be used in new contexts such as military defense, for instance. Therefore, the movement of scientific films cannot only be grasped with linear concepts like biography or trajectory. Reuse practices like recycling, on the other hand, would do justice to both

the medium specificity and the mobility of films. Or what might be described with the words of Balsom as "circulatory reproducibility," as the ability to copy or reproduce film, therefore "transforming that singular trace into something multiple that is primed for circulation" (Balsom 2018, 5).

## Whitewashing Films and Tarnished Institutions

Although the history of this scientific film is not a linear one, its institutional history from the pre- to the postwar period was in many respects rather continuous and trajectable: The usage of the film has basically not changed, as the educational function also remained central in the postwar institution. But to reuse a film which was widely screened in Nazi Germany in directly war-related contexts meant that there were crucial changes necessary on an ideological level: the film as well as the institution needed to be whitewashed from their brown past.

In 1952, the history of C1 and the history of the later IWF intersect for the second time: Gotthard Wolf, now the head of the so-called university and research department of the Institute for Film and Image in Science and Education (*Institut für Film und Bild in Wissenschaft und Unterricht*, FWU) contacted Prandtl again, thanking him for the delivery of the original negatives of the films C1 and C2. Wolf writes that without his help a reconstruction of the film would not have been possible. Furthermore, he mentions that the film is still one of the "most requested films ever."[11] Remarkably, Wolf wrote this letter from Bunsenstraße 10 in Göttingen to Prandtl in Bunsenstraße 10 in Göttingen. After the war, the former buildings of Prandtl's Aerodynamic Research Institute and the Kaiser Wilhelm Institute for Flow Research had to host many of the newly founded institutes of the Kaiser Wilhelm respectively the Max Planck Society, parts of the general administration as well as the IWF (Henning and Kazemi 2016, 38–39).[12] Hence, Bunsenstraße 10 was among the centers of the (re)organization of German cutting-edge research. This must have also shaped Wolf's perspective and his aim to create an internationally recognized institution. To do so, he needed to whitewash the film collection of the RWU, for which "the archives had absolutely to be replenished" again.[13] Thus, Wolf put in great effort to collect either the original material (i.e. from authors like Prandtl) or copies of burned, destroyed or lost films from the *Landesbildstellen* and other institutes. Wolf used both legal and illegal strategies to do so. One rather harmless strategy is described by the historian Ulf Schmidt in his outstanding research on the history of medical research and teaching films from the RfdU/RWU: "In order to gain control over scientific films, Wolf borrowed high-school films from the IfdU [*Institut für den Unterrichtsfilm*] in Munich, but never returned them" (2002, 280).

Besides this restocking of the film collection, the institution and the films also needed to be reorganized on an ideological level in order to be reused. Or to express this in the words of Captain Gregory Buckland-Smith, member of the British Control Commission of Germany and the person responsible for the first comprehensive postwar report on the RWU: "purged of all Nazi and militaristic material," the organization could be reestablished (quoted from Schmidt 2002, 276). The films as well as the institution needed to be denazified—at least *prima facie*. Representatives from the British and American occupying powers viewed, classified and regulated the resumption of the films in distribution. Almost all the films from the university department passed the censorship of the U.S. Office for Military Government for Germany. They only forbade about 15 films out of more than 400, and some others needed to be cut.[14] Nonetheless, the films still needed to be denazified. This process included the replacement of the RWU logo and in some films emblems like swastikas needed to be cut out. Regarding the two films C1 and C2—now heading the media catalogue of the IWF—only the RWU logo was replaced (Fig. 11.1c). Over and above that, the content remained the same.[15]

Besides these official and legal strategies of denazification recommended by the allied powers, Wolf also pursued unofficial strategies in order not to 'lose' too many films: In a letter to the director of the FWU, he suggests replacing the names of biased film authors with the name of their institutes. Among others, this concerns the name of Paul Rostock, former chief of the Office for Medical Science and Research. He was at that time inter alia accused of human experimentation within the Nuremberg doctors' trial. Wolf furthermore recommends not speaking about his suggestion with Buckland-Smith immediately:

> The question is particularly complicated because there is probably a considerable number of films that were made by professors who are no longer in office due to their political views. It would be an extraordinary loss if all these films could not be used in the classroom anymore. Therefore, in individual cases, it may be necessary to only mention the name of the institute from which they originate instead of the name of the person responsible.[16]

By all available means, Wolf was trying to find ways, on the one hand, to seemingly denazify the collection, and on the other hand, to continue to distribute the films from the RWU notwithstanding the issues involved. To reuse the films, one could say, one further strategy to make this continuity acceptable was to whitewash the RWU politically. Schmidt mentioned how not only former RWU and later IWF employees depicted the RWU as a "center of tolerance" and a "political oasis" during the war, but also how this view was reproduced by later historians such as Michael Kühn (1998) and Malte Ewert (1997) (Schmidt 2002, 129–134; see also Kuhlbrodt 1998).

The successful whitewashing of the films as well as the institution was one of the necessary conditions for the reuse of C1 and other films in the IWF, for the reuse of films in the Federal Republic of Germany produced in times of National Socialism and for the goal of *Gleichschaltung*. This underlines again that films cannot be viewed isolated from their cultural, social, institutional and political contexts. Even if films remain mostly unchanged, as in this case (except for the institutional logo), they might be reused in a completely different political environment. Knowing and analyzing these different contexts and environments is therefore absolutely crucial to an understanding of the unpredictable and incalculable reuses of (scientific) films.

As this episode shows, the whitewashing of scientific films does not even need any changes of the content. This says a lot about the deep-rooted assumptions that scientific images are allegedly objective, unpolitical and unideological. The history of Prandtl's laboratory film bears witness to the fact that this may not be the case. Even if brown tinges can be whitewashed, they may still circulate latently with the films and migrate from reuse to reuse.

## Appropriating Found Footage of a Flow Film for US Science Education

The overall structure and appearance of Prandtl's research film stayed largely intact in all its previously mentioned reuses, in spite of all the revisions and refunctionalizations by the RfdU, the RWU and the IWF. Similar to an object reused in a different context, the labels were changed and there were recuts, rearrangements, improvements, damages and small material losses here and there. The following episode of another reuse breaks with any directly recognizable correspondence to the original film: only very few snippets were reused in this case and appropriated to assemble a new product on celluloid.

In the early 1960s, scenes of only a few seconds from Prandtl's recordings appear in the US Science Education Film *The Fluid Dynamics of Drag* (1960) and later in the films *Vorticity* (Fig. 11.1d) and *Flow Visualization*. These films were made at the MIT and became part of an introductory course in fluid dynamics for college students produced by the National Committee for Fluid Mechanics Films (NCFMF). In addition to 39 sound films, the NCFMF later published 133 silent films of a length of 2 to 4 minutes in the Super 8 film format. Seven of them consist entirely of scenes from Prandtl's footage (Shapiro 1972, 172, 182, 207–209).

Ascher Shapiro was head of the program and author of the films mentioned. It is not clear from where Shapiro got the footage. In any case, no correspondence between him and Prandtl has survived. What can be deduced from the image sections and the scenes he reused, especially in the 8 mm films, however, is that Shapiro had 35 mm film material from Prandtl's laboratories available and not only a 16 mm copy

from the IWF of an overall lower quality with cut edges. He may even have had material at hand that Prandtl had left during his world tour. Inquiries of MIT students from the 1930s at Prandtl's Göttingen Institute prove at least that the film had been part of the curriculum long before the foundation of the IWF.[17]

In the history of film, there is an abundance of examples for repurposing film material in new works, usually categorized as found footage films. Especially in avant-garde film since the 1930s, footage of all kinds has been used to craft an entirely different visual experience through editing (Wees 1993; Blümlinger 2009; Jutz 2010). This type of reuse is hardly comparable to the reuse of material objects or still images. While it is quite possible that only individual parts of everyday objects are reused—think of spare parts inventories—, this usually goes hand in hand with the loss of their identifiability. When recycling something (e.g. printed paper) it is often even necessary to erase the previous meaning of the object (e.g. the document). In (analog) film, on the other hand, the reference to the original film is often retained, and in many cases this reference is even foregrounded. The film remains attributable: a link between the reused film and the original film remains recognizable.[18] When you know Prandtl's films, it is easy to identify the snippets from them in Shapiro's college education films. It is important to emphasize this possibility of reuse, which seems specific to film, because it goes along with a different mobility of the film images. The found footage appropriation contributes to the fact that scientific films can overcome spatial, temporal and political boundaries—in some cases surprisingly easily. This happens despite the fact that analog film at least appears to be far less mobile than other scientific inscriptions (compared to the printed image or text, films are expensive, chunky and inflexible in reception or analysis, etc.). In other words, found footage appropriation allows increased mobility as well as increased recontextualization, while keeping a certain immutability of the inscription.[19]

The border-crossing abilities of scientific films (in this case science education films) can also be exemplified by Shapiro's reuse. His films were part of a much bigger educational scheme: Beginning in the mid 1950s, and most notably after the Soviet Union successfully released Sputnik I in 1957, the US Government massively increased the funding of the National Science Foundation in order to improve the teaching and communication of science. A year after Sputnik, the National Defense Education Act was passed, several hundreds of million dollars were directed towards improving American science curricula. New textbooks, source books, classroom equipment and films were developed. The period from the 1950s to the 1970s was the peak phase of educational film production in the US, with more than 10,000 films a year (Orgeron, Orgeron, and Streible 2012, 52). In particular, educational programs in physics played a pioneering role (Rudolph 2012). The science education hype associated with the Sputnik crisis served three main purposes of the US government. First, the new curricula were intended to motivate more students to study

science in order to cushion the sweeping shortage of scientifically trained personnel. Secondly, the courses were supposed to supply the country with personnel who could support the military with scientific means. After all, the extremely successful and almost mythically charged large-scale research initiatives of the Second World War had shown how closely scientific research was linked to any military superiority. And third, the curricula were part of a cultural-psychological war over the power to define research and science. Particularly the discipline of physics stood for rationality, freedom of ideology and freedom of research. While the Soviet Union was waging a struggle against "bourgeois science," science in the West was regarded as an apolitical undertaking. The paradox, however, was that it was precisely this seemingly "unpolitical" science that was a cultural weapon with which the US government wanted to counter totalitarian regimes and lead the world to democracy (Wolfe 2018). As part of this cultural war, science education films were distributed globally, dubbed in several languages or offered for appropriation in other school systems—with funds from the US government and intelligence agencies, among others. As a result, Shapiro's films with the snippets from the Göttingen flow films were also distributed worldwide. They are still in use today and are available on several video-sharing platforms. Some reach click counts in the six-figure range.

Shapiro's appropriation of parts of Prandtl's film demonstrates that scientific films can bridge geographical, chronological and political rifts in an especially smooth manner when used as found footage. A mere reuse of the National Socialist university teaching film C1 for US science education would hardly have been conceivable outside the small community of specialists in fluid dynamics. However, the use as found footage does not imply that it was employed only accidentally as an *objet trouvé*, or as orphan film. The reuse was rather programmatic: Shapiro's first film is one of the very, very few of the physics education films that show research film material that is neither closely connected to the experimental apparatuses featured in the films nor produced in the US. But particularly the publications accompanying the film emphasize that the connection between the two films is not just to be found in some snippets. Shapiro published a book that he describes as "the film in print." In the preface he states: "I am indebted . . . to the late Ludwig Prandtl for classic film sequences now thirty years old as well as the inspiration of his style . . ." (Shapiro 1961, xv). And even its cover cites the Prandtl movie (Fig. 11.2). Shapiro roots his educational film project for the Space Race and the cultural war with the Soviets in the tradition of Prandtl. Hence, at least elements from Prandtl's film served as a main ingredient for educational films not only in 1930s Germany but also in 1960s US science education.

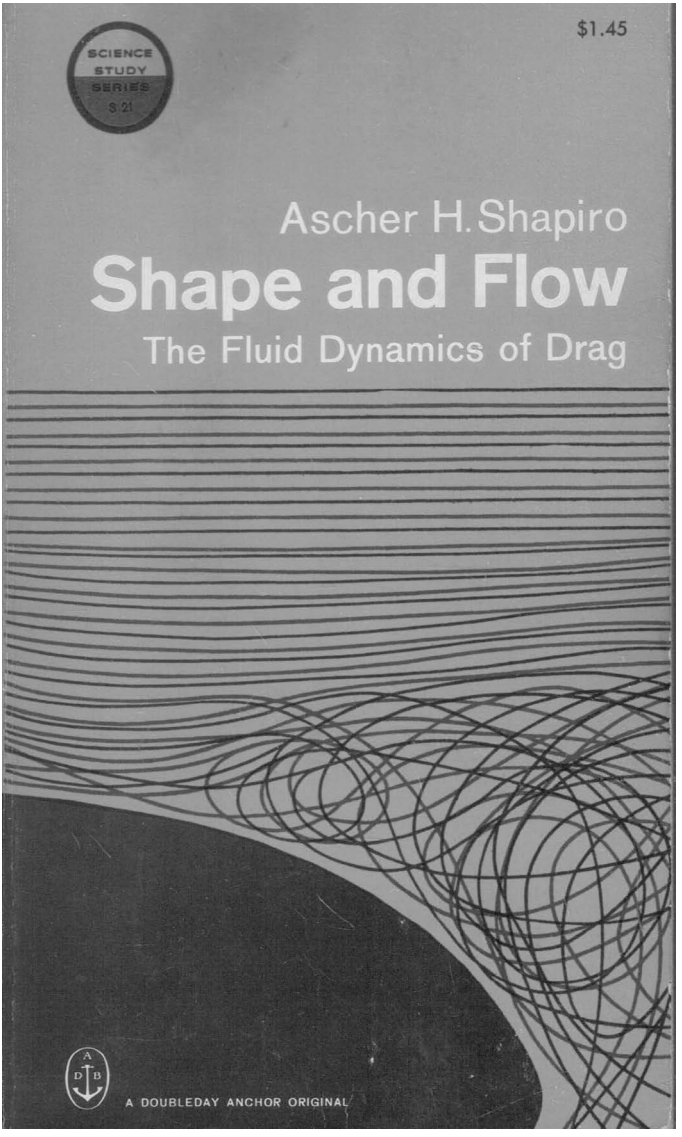


Figure 11.2: Book cover of *Shape and Flow*, which cites a scene from Prandtl's movie.

## Remembrance: The Film as Historical Testimony

In the penultimate episode, we return to the plaque installed in commemoration of Ludwig Prandtl in Göttingen in 2009. As mentioned at the beginning, the *Göttinger*

*Tageblatt*, in cooperation with the IWF, published a DVD with Prandtl's flow film on the occasion of this event (Fig. 11.1e). In the course of commemorating Prandtl's successes and his reputation, the film was treated as if it were an object of remembrance: "Old Films New on DVD" and "Historical Films of Vortices and Currents" headlined the articles in the *Göttinger Tageblatt*, and the IWF press release talks about the "nostalgic appeal" of the "authentic" research recordings as well as their "clarity and validity" (IWF 2009).

The former laboratory film, then educational film, then archive film, thus became a memorial film, analogous to the objects of remembrance in museums or, more generally, in public spaces that recall the great and small achievements of the dead. The term memorial film does not signify a film whose content is memory or remembrance, but a film that is a historical testimony in itself and to which collective or individual memory can be attached (Erll and Wodianka 2008). As such, the flow film served a double commemoration. On the one hand, Prandtl, the "father of aerodynamics," was remembered. Thereby, the film illustrated Prandtl's field of research, his ideas and his ability to bring together the image and mathematical theory of flow (Broelmann 2001, 16). Thus, it also represented the glorious past of Göttingen science at the beginning of the 20th century. On the other hand, the film release commemorated the institution that had distributed the film (and many others) internationally for over 70 years. After all, the IWF was already at a late stage in its decline at that time. A little over a year after the DVD was released, the IWF was finally liquidated.

This episode stands for yet another kind of reuse typical for objects that mediate between the individual and society. The film was transformed into a means of collective memory and thus served different political intentions of the past. It was now tourism marketing for the "city that creates knowledge," a memorial to a figurehead of aerodynamics and a monument to a dying institution, which was once of great international importance for scientific film. Much could be said and questioned about the function and category of memorial film. To what extent did the film serve an individual, social, collective or political memory? To what extent can scientific films, which are characterized by the assertion that they depict something timeless, independent of place and time—which is particularly true of the physical disciplines—be functionalized as bearers of memory?

These questions cannot be answered here. What is decisive at this point, however, is that a perspective on the reuse of scientific films raises precisely these questions and makes them addressable. This underscores the fact that the imperative *follow the films!* not only provides insights into the historicity of the medium and its subject, but also exposes a kaleidoscope of historically different public approaches to the sciences.

In recourse to the concept of object biographies already presented, one could speak here of a rapprochement between the biographies of the film and its author

after years of separation. In commemoration, the object finds its way back to its original owner Ludwig Prandtl. The biography of the film is a co-biography of its creator in his 'afterlife' as well. But the film does not end up as a memorial object. Rather, at this point it takes an unforeseeable turn and its story continues.

In regard to this subsequent as well as to the previous reuse as a commemorative film, a mediatechnical *a priori* was crucial: The recordings, once produced on 35 mm material and then distributed on 16 mm, had to be digitized, MPEG2-encoded and stored on DVD. The reformatting (Rothöhler 2018) of the analog material meant, on the one hand, a massive loss of quality (image resolution in Pal standard)—which in the rhetoric of the circular economy can be described as 'downcycling.' On the other hand, the transition to another format and its digital publication enabled new uses for the film.

## Palimpsesting: Reentry in the Research Context

Paradoxically, the release of the film on DVD, which for the first time in the film's history was aimed at a larger nonscientific or nonschool public, led to a reentry into its original scientific discipline: fluid dynamics. As there was an image plane added to the film, this reuse can be specified with the practice of palimpsesting, an early cultural recycling technique, which is characterized by the layering of different pictorial/temporal planes.

Jürgen Kompenhans, head of the experimental methods department at the German Aerospace Center, was among the readers of the *Göttinger Tageblatt*. Prandtl and his research were well known to him. He immediately ordered several DVDs of Prandtl's films and analyzed them with his colleague Christian Willert using particle image velocimetry (PIV). PIV is an algorithm-based optical analysis method for flows, which has evolved since the 1980s and is now one of the standard methods in fluid dynamic research. Kompenhans himself played a decisive role in its development. However, Willert and Kompenhans did not publish the data obtained from their PIV analysis, but in turn produced a film entitled *PIV Analysis of Ludwig Prandtl's Historic Flow Visualization Films* (Fig. 11.1f; Willert and Kompenhans 2010). Similar to Prandtl, Willert and Kompenhans showed their PIV film at conferences. In June 2010, they received the Best Movie Award at the 14th International Symposium on Flow Visualization in Daegu, South Korea. 80 years after the creation of the flow film, its reformatting and rerelease on DVD thus led to a reentry into its original research context, which had changed in terms of the technological possibilities for quantifying and dating the phenomena.

What does this film show and in what way is it a palimpsest? The film visualizes data obtained by a numerical analysis of the digitized historical film material. Colorful areas and streaks can be seen behind black objects on a grey background

with white dots. If one reads the film images together with the scale in the lower right corner, it becomes clear that the colored as well as the white areas provide information on vorticity, which describes the rotation of fluids around their own axis and is a central parameter in meteorology and fluid mechanics. What is decisive at this point is that the original film shines through the colored areas as a black-and-white background. The superimposition of colorful visualized data and translucent black-and-white film corresponds in its visual appearance to a palimpsest. Originally, palimpsests were used to designate texts that were removed from their material carrier by scraping or washing, so that the document could be reused for new texts. The deeper layers remained more or less visible, which could lead to correlations of meaning. Palimpsests with their different layers of meaning have been prominently theorized in literature, postcolonial theory (Osthues 2017) and image studies (Krüger 2007). As a "cultural technique of early recycling," palimpsesting enabled valuable material to be reused and recodified or even eradicated (Krüger 2007, 140).

Willert and Kompenhans' reuse of the film is essentially characterized by an intervention into the layers of the film image and differs in this respect from the practices discussed so far. The layering of current data visualization and historical flow visualization also enables new forms of knowledge. The layered image thus makes the historical circulation of knowledge images visible. Willert and Kompenhans not only turned Prandtl's research film into a data film (Adelmann et al. 2009), but also traced the PIV method back to its historical origins. In the film palimpsest, the historically superimposed layers are quasi reconciled. From a science-historical perspective, one could say that Willert and Kompenhans argue with images about images, with films about films. In doing so, they demonstrate what is still considered a desideratum in both the text-heavy humanities and the data-driven natural sciences: the acknowledgment of (scientific) images and films in their historical, material and aesthetic multilayeredness as visual arguments.

## Conclusion

The "object biography" is probably the most prominent concept that lends itself to following the circulations, trajectories or better, reappearances of scientific inscriptions after their production in the laboratory. By providing a narrative hook for a longer historical time span and at the same time allowing for case-based analysis of situated practices, a film biography, modeled on an object biography, also delivers valuable ideas to better understand the multiple and subtle forms of intertwinement between science, politics and the public sphere. Nonetheless, we have argued in our article that, especially in view of the media specificity of film (as a reproducible, material and visual 'object' that is realized when screened), the biog-

raphy-approach needs to be adapted to describe the circulation of knowledge and power through scientific film. Hence, it is a matter of how to obtain the advantages of the concept without falling into its traps of implying a singular path or even anthropomorphic life cycles of films. Therefore, we suggest generally expanding our repertoire of investigating film migrations and relocations by focusing on the often-contingent reuses and reappearances of a film throughout history. A conceptual toolbox for describing single reuses is needed, so that not just *the* one but all or most of the itineraries of a scientific film can be followed and retraced. Fields like circular economy, for instance, which seem at first glance to have little to do with film and knowledge circulation, as well as closer fields, like the literature on found footage art films, can serve as rich conceptual, methodological and practical sources. In this toolbox, object biographies, trajectories and circulations should be supplemented by film reuses from up- or downcycling to whitewashing, to found footage appropriation, to reediting for remembrance, to palimpsests, and maybe more.

Prandtl's film is assuredly one of the most remarkable examples of a scientific film. Prandtl produced a research film hoping to take measurements in the 1920s. What he got was a film that secured the legacy of his visualizations not only in Nazi Germany and in West Germany, but also during the Cold War period in the US and in the present Flow Vis community. In order to discuss concepts of film reuse, this article has caught some glimpses of this film's even broader history. Above all, there is a need for further discussion on why especially this film has traveled so well through time and space and is still in use today. In short, there is a wide array of reasons for its long journey, beginning with the influence and fame of its maker Prandtl and the special significance of the subject it deals with. After all, in the last 100 years the acceleration of movement through air and water became one of the central goals for military as well as civil technological development. From this perspective, it is not surprising that a film promising to provide a key to understanding these movements has had a particularly successful career. Nonetheless, there are other reasons why this film in particular survived long after its first examination in the laboratory: its "immediate clarity" (Wise 1995, 231), its aesthetics, its hypnotic character, the pleasure it provides, but also the specific and complex history of the film itself. After all, the routes of circulation the film took created path dependencies that secured the next reuses of the film. For example, without its prominent position in the media catalogue of the RfdU/RWU and later the IWF, it would never have been PIV-analyzed 80 years after its production.

To conclude, in the last 50 years, studies in the history of science, technology and media have embraced a focus on practices of knowledge production and circulation. Along with that, master narratives of ingenious men and inventions were questioned, which have long dominated the field and which scarcely leave room for friction and fractions. Following scientific films can add to these critical ap-

proaches and help to fill a gap in the increasing literature on the visual practices of science (Beaulieu 2014; Galison 2014). Instead of emphasizing ideas, theories or experimental settings of scientific knowledge production, a focus on the reuses of scientific films—understood as correlating the production, distribution, reformatting, archiving, reception and other forms of reusage with one another—supplements historical epistemology with the possibilities of a political and economic epistemology of the visual.

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## Archives

Archive of the Max-Planck-Gesellschaft (AMPG), Berlin.

Central Archive of the German Aerospace Center, Göttingen.
German National Library of Science and Technology Archives (TIB), Hanover.

## Notes

1 This research was funded by the Swiss National Science Foundation (Grant 173038). We would like to thank Anja Sattelmacher very much for her valuable contributions in terms of initiative, concept and discussion related to this article.

2 "Für das, was nun weiter erfolgt, ist also keine eigentliche Theorie mehr vorhanden, sondern nur eine an dem Anschauungsmaterial geprüfte qualitative Lehre, die nicht mehr in der exakten Sprache der Formeln ausgedrückt werden kann."

3 On this and the following details about Prandtl's trip around the world, cf. the correspondence in the Archive of the Max-Planck-Gesellschaft (AMPG III/61/1984; AMPG III/61/1985) and the "Bericht über eine Studienreise durch Amerika" in the Central Archive of the German Aerospace Center (GOAR 3663). In the following, all archival materials will be referenced in endnotes.

4 "Durch die Herauslösung aus ihrem ursprünglichen Kontext werden Gebrauchsfilme . . . in einen neuen Adressierungszusammenhang gestellt."

5 Bernhard Rust, Runderlass 06.02.1935 (AMPG I/44/1305).

6 "Diese Arbeitskopie, die in wahlloser Folge einzelne Negativabschnitte enthält, ist auf eine sinngemässe Fassung zu schneiden und zu kleben. Diese Fassung müsste möglichst schon den Anforderungen des Hochschulunterrichts gerecht werden." Dautert/Schwarz to Prandtl, 1935 (AMPG I/44/1305).

7 See the correspondence of Prandtl and the RfdU, 1935–37 (AMPG I/44/1305; AMPG I/44/1306).

8 Von Werner/Schwarz to Prandtl, 1935 (AMPG I/44/1305).

9 See "List of the 50 most requested university films" (Liste der 50 meistgefordertsten [sic] Hochschulfilme), n.y., probably around 1948 (TIB IWF 12485).

10 Correspondence of Wolf/RfdU and Prandtl, 1936 (AMPG I/44/1306).

11 ". . . noch immer zu den meistgefragtesten Unterrichtsfilmen überhaupt . . ." Wolf to Prandtl, 1952 (AMPG III/61/739).

12 The history of the RWU's subsequent institutions in the time after 1945 and before the official foundation of the IWF in 1956 is complex, but important for an understanding of the history of scientific films in Germany: in September 1945, the former university department and the special department for technical research film (*Sonderreferat technischer Forschungsfilm*) of the RWU already received a work permit as the department of technical research film (*Abteilung*

*technischer Forschungsfilm*) under the direction of Wolf in Höckelheim. At the end of 1945, the Institute for Film and Image (*Institut für Film und Bild*, IBF) was founded in Hamburg (but also active in Hanover) belonging to the British zone. Schmidt points out that many of the former RWU personnel "affiliated with the regime, made their way into the British zone" most probably due to the more modest program of denazification there (2002, 279–280). Furthermore, if the Allies wanted to quickly reestablish the organization, they rather needed to softly vet the RWU personnel (282). In 1946, the Institute for Educational Film (*Institut für den Unterrichtsfilm*, IfdU) was founded in the American zone and was based in Munich. The IfdU and IFB "were competing for financial resources, film equipment, raw film material, negatives and film copies of the former RWU stock" (275). As a result of the union of the three Western zones into the Trizone, and the increasing doubts "over the character of the Hamburg institute" (281), both institutes merged in the Institute for Film and Image in Science and Education (*Institut für Film und Bild in Wissenschaft und Unterricht*, FWU), based in Munich in the US sector. Wolf's Höckelheimer Group became the university department of the trizonal FWU, and it was moved to Göttingen in 1949, directly on the site of Prandtl's Aerodynamic Research Institute, into the removed wind tunnel at Bunsenstraße 10 (Ewert 1998, 233–234; Kühn 1998, 235–238; Schmidt 2002, 275–284).

13 ". . . dass wir unbedingt unsere Archive wieder auffüllen müssen." Correspondence of the Göttinger university department with the FWU concerning orders of copies, 1951, see also the correspondence with the *Landesbildstellen* (TIB IWF 16083).

14 Correspondence Wolf (at that time *Institut für Film und Bild in Wissenschaft und Unterricht* in Höckelheim) with Krämer from the Munich institute (at that time *Institut für den Unterrichtsfilm*, IfdU), 1948 (TIB IWF 16083); see also in-house correspondence in the Göttingen institute, 1950 (TIB IWF 12485); and the vetting results of the U.S. Office for Military Government for Germany, 1948 (TIB IWF 12863).

15 This can be shown from a comparison of the correspondence between Prandtl and the RfdU about the used material, the narrative structure and the intertitles (AMPG I/44/1305; AMPG I/44/1306).

16 "Die Frage ist aus dem Grunde besonders kompliziert, weil sicher eine beträchtliche Anzahl unserer Filme Professoren als Autoren haben, die jetzt wegen ihrer politischen Einstellung nicht mehr im Amt sind. Es wäre ein ausserordentlicher Verlust, wenn alle diese Filme im Unterricht nicht mehr eingesetzt werden dürften. Vielleicht müsste in einzelnen Fällen von der Möglichkeit Gebrauch gemacht werden, die Namen der Sachbearbeiter nicht mehr in Erscheinung treten zu lassen, sondern nur noch das Institut, aus dem sie stammen." Wolf to Schmid, 1947 (TIB IWF 12848).

17 Edgardo N. Accinelli to Prandtl, 1939 (AMPG I/44/209).

18 However, it should be pointed out that sometimes reused image sections (to a certain extent the rigid equivalent to the scene/sequence of a film) can also retain their connection to the image from which they are taken. Just think of the ubiquitous angels of the Sistine Madonna. Such reuses are usually only reserved for this type of blockbuster image.

19 This resonates with the discussion on the extent to which scientific films can be grasped as "immutable mobiles" (Latour) or "boundary objects" (Star and Griesemer) (Hoof 2014, 57–59).

# 12. Extraterrestrial Images

*Tomáš Dvořák*

## Recognizing Images from Far Away

From the early 1920s, Wilfred I. Eitzman, a science and mathematics schoolteacher from South African Pietersburg (currently Polokwane), repeatedly visited limeworks in the nearby Makapansgat Valley. He was attracted by fossil bone deposits exposed during the mining of lime. The remains were later identified as belonging to *Australopithecus africanus* and being some 3 million years old. In a 1958 article, Eitzman recollects his explorations in the Makapansgat caves, as well as his efforts to draw the attention of scientists and the general public to the site, most of which was irretrievably lost due to the voracious demand for lime (according to his estimates, some 60,000 tons of lime had been removed from the caverns between 1922 and 1937). Even though only a fragment of the original geological deposits remained available for later research, Makapansgat is one of the greatest paleontological records of human evolution in the world.

In the article, Eitzman incidentally mentions his discovery of a remarkable water-worn pebble, extracted in 1925 from a bone breccia and "retained by him ever since because of its extraordinary resemblance to a human face, which he also felt was responsible for its having originally been brought into the cavern by *Australopithecus*" (1958, 180). What later became known as the "Makapansgat pebble" (or, more precisely, cobble) is a small, reddish-brown jasperite stone with surface markings resembling a rudimentary form of a human face. The cobble was found in the sediment associated with australopithecine bones tens of kilometers away from any possible natural source of such stones—hence Eitzman's assumption that someone had to have picked it up and carried it to the cave, most likely because of the appeal of its appearance.

Prehistorian and cognitive archaeologist Robert Bednarik (1998) studied the stone meticulously in 1997 to verify that the markings on its surface were not made or even emphasized by the *Australopithecus* but rather of natural origin. The stone doesn't bear any trace of artificial modification; it was not made but found. The Makapansgat cobble, c. 3,000,000 BP, is the earliest known example of what is called a "manuport" (a natural object which has been moved from its original con-

text by human agency but otherwise remains unmodified), or, to use a contemporary art-world term, it is the first "readymade." Many scholars assume it exhibits an incipient form of consciousness, symbolic thinking, and possibly an aesthetic sense. Paleoanthropologists like to think of the cobble as of the most ancient art object in the world, one that by far predates any kind of human-made rock art or cave art.

However speculative it may be, the story of the Makapansgat cobble makes for a fascinating thought experiment, one that challenges our customary understanding of the emergence of humanity and beginnings of art, as the stone image does not exemplify the peculiar "human" ability to make things but rather a simple form of pattern recognition and apperception. In the often-retold story of this oldest "art object," we must, however, distinguish between two different acts of recognition. The face in the stone was recognized "first" by Eitzman in 1925 (as it is recognized by us looking at it in exhibitions or book reproductions today), who picked it up and has "retained [it] ever since." And, given its atypical deposit, we suppose the *Australopithecus* must have picked it up for the very same reason and liked it so much that she or he carried it the long way back home without even having a pocket or a purse. (Things get more complicated if we turn the stone upside down: It shows not one, but in fact at least two different renditions of a face, one smiley-like and one more apish. It is not certain that even if the *Australopithecus* recognized something in the stone, they did recognize the same image as Eitzman or as we do, given the typical orientation of the image in its reproductions.)

The real enigma lies in the trajectory this image has travelled. Or, more precisely, trajectories, as there are two involved. One is the dislocation that took place circa 3,000,000 years ago, at a time when no one had a reason to move stones around and they kept lying where they, so to speak, developed. Then, one mysterious hominin came around and carried this stone several kilometers away from its natural source, for whatever reason. The second trajectory is no less enigmatic—it is not so much a transmission in space as a transmission in time. The jasperite stone joined the bones of its finder on a long journey of sedimentation, becoming a time capsule hidden in what modern humans have later (fortunately?) considered a valuable commodity. As Eitzman notes, most miners were rough, illiterate men—a different kind of intelligence was needed to recognize a different kind of treasure with a different kind of meaning and value in the natural treasure. A cultured high school teacher with a noble hobby had to come along to recognize a message, albeit unintentional, from his ancestor with a similarly exceptional inclination. For both of them, a piece of rock was more than just a piece of rock. It carried a sign or at least an indication of behavior that may be called intelligent, even if not necessarily human.

In my contribution to this volume, I want to focus on a rather extreme form of image trajectory: on images that travel in space but also and more importantly

in time, on images that become time capsules to be deciphered by a different kind of civilization to the one that has made or sent them. We can call them extraterrestrial images; even though some of them, as the example of the Makapansgat cobble suggests, have remained still at the same place on our planet for millions of years, the thin layer on its surface where life takes place and which we call our home has transformed profoundly over those vast reaches of time and has become a different world entirely. I will, however, focus mainly on images that we, as modern humans, send to outer space to communicate with other beings. The "other" in extraterrestrial communication always implies "future"—not only in the sense that the images might meet their receivers in some indistinct futurity, but also in the sense of hoping for more "advanced" or more "civilized" receivers of our messages. In the final chapter of his *Geology of Media*, Jussi Parikka moves "from deep times to future times by speculating on the idea of future fossils, as a future temporality turned back to the current moment" (2015, 109). I want to follow this move while investigating the ways in which extraterrestrial images radically challenge our prevailing notions of time and our understanding of communication. The temporal framework of our media and communication theories is usually circumscribed by the humanly meaningful coordinates ranging from immediate interaction to millennia. As we face growing concerns about the future of human survival on Earth, we are urged to think on a very different scale and to extend our imagination beyond these limits, both in terms of time and forms of life: "A vision of communication committed to democracy cannot foreclose on entering into intelligence with radical otherness, including the earth, other species, machines, or extraterrestrial life" (Peters 2003, 399).

## Ultima Thule

Before we take a closer look at some of the images travelling in outer space, I want to touch briefly on the image of space travel—on the imaginary, mainly literary renderings of extraterrestrial contact, which show to what extent travel and transportation are aligned with images and vision. Any communication with extraterrestrials has been imaginary so far, of course. Yet we can distinguish between fictional accounts of any kind of encounter with aliens and actual efforts to send out or receive messages, even though no form of reciprocal communication has been established. Before the nineteenth century, when the telegraph severed the physical link between the messenger and the message, thus separating communication from transportation, one had to travel "in person": the astronaut's body was the prime medium of communication, as the message could not yet be transported without the messenger.

Possibly the most influential of the ancient (preserved) records is Plutarch's dialogue *Concerning the Face Which Appears in the Orb of the Moon* from the end of the first century (1957). A group of learned men discuss the size, shape and distance of the Moon, its phases, eclipse and the nature of its light; thanks to its many references to older thinkers, the book is an important source of knowledge about ancient astronomy and cosmology. The starting point of the dialogue is a "face" seen by many in the spotted surface of the Moon—a classic example of visual pareidolia, the tendency to perceive shapes, often anthropomorphic, in indistinct visual cues. The men also discuss the surface of the Moon and ponder whether it is inhabited, let alone inhabitable. One of the speakers claims that without life or at least the possibility of life, the existence of the Moon would have no purpose, while another speculates about extraordinary beings and life forms incomparable with those living on the Earth. During the debate about the lunar living environment, Plutarch voices a soft critique of anthropocentrism. We can find territories hostile towards human beings and life in general, even on Earth, such as oceans and deserts. But it does not imply that they would have no metaphysical purpose: the world was not made for humans and the inhabitable parts belong to it as well. The dialogue ends with a platonic eschatological myth in the form of a retelling of a narrative by a certain stranger, who has visited the Isle of Cronus, a five-day journey westwards of Britain, populated by Moon-worshiping people. He learns from them that the Moon is a kind of purgatory, inhabited by human souls before their descent to Earth.

Travelling beyond the borders of the known world, to an indeterminate location that classical literature often refers to as "ultima Thule," means reaching a point when outer space can be more or less easily accessed or rather, when the distinction between the inner and the outer, between Earth and the cosmos becomes blurry and obscure: celestial bodies become no more than other islands in a vast and unexplored ocean. In his satirical travelogue *A True Story*, Lucian describes a journey into the western ocean: setting out from the Pillars of Hercules, the travellers first reach the strange Island of Dionysus. When they continue their journey further, they land on the Moon:

> About noon, when the island was no longer in sight, a whirlwind suddenly arose, spun the boat about, raised her into the air about three hundred furlongs and did not let her down into the sea again; but while she was hung up aloft a wind struck her sails and drove her ahead with bellying canvas. For seven days and seven nights we sailed the air, and on the eighth day we saw a great country in it, resembling an island, bright and round and shining with a great light. Running in there and anchoring, we went ashore, and on investigating found that the land was inhabited and cultivated. (Lucian 1961, 259)

During their visit to the Moon, the travellers meet many different peoples of various habits and appearances. The Moonites are not born of women but of men (there are no women, in fact: up to the age of twenty-five, each is a wife and thereafter a husband); men also give birth to children. Some carry their children in the calf of the leg, and when conception takes place the calf begins to swell and they cut it open. The child is delivered dead but they bring it to life by putting it in the wind with its mouth open. Another kind, so-called Arboreals, remove their right genital gland and plant it in the ground—a very large tree resembling a phallus with large acorns grows up from it. When the acorns ripen, new people can be shelled out of them. Only a bald man is considered beautiful on the Moon; some Moonites blow honey from their noses and sweat milk, some have removable eyes and can exchange them with others. In the royal district, they have a large mirror fixed above a well. From inside the well one can hear everything that is said on Earth and by looking at the mirror one can also see anything or anyone there as if one were next to them.

Lucian dedicated one more piece to space travel, a short dialogue called *Icaromenippus, or the Sky-Man*. This work is much more explicit in relativizing earthly habits, norms and truths. Menippus, the protagonist of the story, sets out on his journey because he is dissatisfied with contradictory claims of philosophers and mathematicians about the nature of the universe and hopes to gain a detached view from above by cutting one wing from an eagle and one from a vulture and attaching them to his body. He flies up to celestial spheres with a short stop at the Moon. The visit is not so much an exploration of the satellite as an opportunity to look back at Earth.

First, however, Menippus needed to adjust his sense of sight, as he was able to recognize the Earth from such a great distance but could not make out any details. Empedocles approached him (apparently the only inhabitant of the Moon, burnt and smoldering like a cinder, since the smoke from a volcano he threw himself at brought him up there) and advised Menippus to sharpen his vision by flapping his right arm with the eagle's wing, thus becoming half-eagle and transferring the animal's unique power of vision to his right eye as well.

When Menippus finally sees life on Earth in bright detail, his experience is very different from the overview effect reported by modern astronauts: terrestrial life seems petty, vain and ludicrous, full of conflicts and discord. Even the Moon herself is disgusted by what she has to observe each night, as well as by "hearing quantities of dreadful abuse from the philosophers, who have nothing else to do but to bother about me, what I am, how big I am, and why I become semicircular, or crescent-shaped. Some of them say I am inhabited, others that I hang over the sea like a mirror, and others ascribe to me—oh, anything that each man's fancy prompts" (Lucian 1960, 303). As Menippus plans to continue his journey further toward the heavens, the Moon asks him to deliver a message to Zeus:

> So be sure to report all this to Zeus and to add, too, that I cannot remain in my place unless he destroys the natural philosophers, muzzles the logicians, razes the Porch, burns down the Academy, and stops the lectures in the Walks; for only then can I get a rest and cease to be surveyed by them every day. (Lucian 1960, 305)

The Moon enjoyed relative peace until the beginning of the seventeenth century, when Galileo's telescopic observations aroused new interest in the satellite's surface and secrets. From Kepler's *Somnium*, written in Prague in 1608, in which the lunar adventure prepares ground for an exposition of an alternative lunar astronomy and a defense of the Copernican doctrine of the motion of the Earth, to John Wilkins's *Discovery of a World in the Moon*, Francis Goodwin's *Man in the Moone*, Athanasius Kircher's *Ecstatic Journey*, Bernard de Fontenelle's *Conversations on the Plurality of Worlds*, or Christiaan Huyghens's *Cosmotheoros*, space travel becomes a pretext for explaining the nature of the cosmos, musings on the plurality of worlds and the possibility of life on other planets, or speculations about alternative biological and social structures.

The imaginary space journey is never just the transfer of the traveler's body (whether it moves thanks to a ship, demons, or a flock of wild swans) but always has a visual component, includes some sort of optical apparatus or some mode of enhancing human vision or that which is to be seen. This is apparent especially in pre-telescopic works, such as Plutarch's or Lucian's, or in later visual renderings, for example the cinematographic, such as Méliès's view from the perspective of the flying projectile in his 1902 *Trip to the Moon* or in the actual cosmic flights since the 1960s, which were upheld by the cybernetic vision of the control-room: "one cannot imagine the technical state of space travel arbitrarily separated from the perfection of the process of transporting images" (Blumenberg 1987, 676). To establish contact with outer space, vision must become extraordinarily mobile and swift, also extending with the movement of the messenger. In its simplest form, extraterrestrial contact required a gigantic image: the Moon would become an image of a face or, as a number of eighteenth and nineteenth-century authors suggested, one could create a massive image on the surface of the Earth (Camille Flammarion suggested creating large arrays of electric lamps, Joseph von Littrow proposed a massive circular canal in the Sahara desert filled with burning kerosene, Carl Friedrich Gauss reportedly suggested planting trees in the Siberian tundra in the shape of an immense right-angled triangle with three squares, intended as a symbolical representation of the Pythagorean theorem). Whatever the technique, it seemed only natural that establishing contact with extraterrestrials would involve seeing them or being seen by them through some kind of rescaling of vision. The preference for the optical is conditioned by the fact that vision is a distant sense, but also indebted to the tradition of astronomical observation and to the understanding of an image as a universally intelligible, transparent message.

## Moving Images and Communication between Species

The phrase "moving images" typically evokes films (movies, motion pictures) created either by photography or animation: the process of capturing, storing and reanimating scenes by projecting a rapid succession of discrete images. Yet both the emergence and development of these moving images is closely interlaced with another mode of movement, one of transmitting images over distances, whether by cables or wirelessly. Most media histories tend to treat these two forms of movement separately and distinguish between technological systems of recording/projection and transmission while drawing on a more general distinction between temporal and spatial media bias. So far there have been only a few scholarly studies questioning the dividing line between the recorded and the transmitted and instead exploring their intermedial influences and amalgamations. Geoffrey Batchen's remarkable genealogy of new media outlines, among other things, the early history of photographic image transmission methods using telegraphic wires:

> A key breakthrough came in July 1838, when the Englishman Edward Davy was granted a patent for an electric telegraph system in which a current being received is passed through a moving paper tape soaked in potassium iodide, thus leaving a colored mark with each flow. Electricity was thereby turned into a legible image, moreover a kind of image produced very much like a photograph (automatically, as a chemical reaction to received energy). (2006, 36)

More recently, Doron Galili's discussion of the late-nineteenth and early-twentieth century discourses and technologies of the cinematic and the televisual showed that "photographic and electric moving image media were not necessarily understood as separate, mutually exclusive entities" (2020, 75) but were imbricated in a shared genealogical fabric of modern audiovisual culture.

Thanks to the development of electrical telecommunication systems, the ultima Thule moment reappears in the nineteenth century: transmitting messages over the final distances on the globe opens up the possibility of transmitting them to other celestial bodies as well (intentionally, and also as a side effect of terrestrial communication). The main hindrance to be considered, of course, is the existence of a receiver (both technological and intelligent) at the other end of the transmission. That is why the communication begins more cautiously in the mode of signaling rather than actual transmission, following, in a sense, the development from the optical to the electric telegraph.

Possibly the first scrupulous program for extraterrestrial communication was suggested by Edvard Engelbert Neovius, Finnish officer and mathematician (for more details, see Lehti 1998). In 1875, Neovius published a booklet entitled *The Greatest Mission of Our Time*, in which he proposed contacting the inhabitants of Mars us-

ing light signals projected by huge beacons. Inspired by Flammarion and Oersted, Neovius believed that practically every planet has intelligent inhabitants, very similar to Earthlings. He also subscribed to the view that the cosmic development of planetary systems proceeds from the edge to the center, which made Mars (being more advanced as a celestial body but also in terms of the evolution of organic beings) the ideal addressee for his message. The message itself, sent by a sequence of light pulses, was analogous to Morse code, which was most likely one of the topics Neovius taught to his students at Hamina Cadet School.

In 1896, Francis Galton suggested a very similar project, still framed in the traditional genre of fantastic literature and presented as a series of imaginary news reports. But it already articulates all the key aspects of interplanetary and interspecies communication (for an overview of extraterrestrial languages, see Oberhaus 2019): "Signals have to be devised that are *intrinsically* intelligible, so that the messages may be deciphered by any intelligent man, or other creature, who has made nearly as much advance in pure and applied science as ourselves" (Galton 1896, 657—emphasis FG).

Galton realized that such communication necessarily lacks any kind of feedback, at least in its initial stages, and thus must involve some sort of "intrinsically intelligible" signals. Interestingly enough, his imaginary reports start with signals being broadcasted from Mars: "Astronomers in various observatories have been much excited of late by the sight of minute scintillations of light proceeding from a single well-defined spot on the surface of Mars, and they are becoming greatly perplexed as to the significance of this strange phenomenon" (1896, 658). The scintillations are produced by an assemblage of heliographs and formed by patterns of dots, dashes and lines—flashes differing in their length and also in the length of intervals between them, which indicate differences between letters, words and paragraphs. The signaling starts with a phatic phase—a succession of lines with intervening pauses, to suggest a communicative intent simply by the regularity of its pattern, then moves on to the definition of basic arithmetical operations and to the description of planets, their distance from the Sun or rotation period, in order to somehow identify the circumstantial coordinates, the whereabouts of the conversation. The "final and most marvelous stage" is one of "effective picture-writing in outlines by means of series of words of three letters" (1896, 662), which can be used to communicate more complex concepts. Galton compares the method of "picture formulas" to expressing the directions and lengths of stiches in a piece of embroidery and refers to his earlier lecture on the "just-perceptible difference" given at the Royal Institution in 1893. Drawing on Gustav Fechner's psychophysical theories and experiments (in which Fechner gradually, in small increments, increased the intensity of some sensory stimulus and then recorded and quantified the subject's perceptions in order to determine the relationship between physical stimulation and psychological experience), Galton deals with "the limits of the power of optical

discrimination, as shown by the smallest number of adjacent dots that suffice to give the appearance of a continuous line" and the feasibility of "transmitting very beautiful outline drawings of a minute size, and larger and rougher plans, maps, and designs of all kinds, by means of telegraphy" (1893, 13). In other words, Galton proposes a clever trick: we can exploit the limits of the power of optical discrimination (when in proper size or from a proper distance, a series of dots appears to be a continuous line) to break down the image into discrete picture-elements, which can be converted into signals, transmitted over distance and then reconstructed into the image. His technique of converting images into picture-formulas made of letters, words or numbers also has an economic advantage, as sending strings of texts is much cheaper and faster than using the pictorial telegraph.

The first attempts to communicate with extraterrestrials concerned the neighboring celestial bodies, namely the Moon, Venus and Mars. There were two main reasons for this rather limited field of contact: First, many believed or would at least speculate about intelligent beings living on these nearby planets, as only improved early twentieth-century astronomical observations definitively ruled out any signs of (intelligent and contemporaneous) life on them. Second, communication technologies at that time could not reach greater distances. As a result, the prospect of extraterrestrial communication remained confined to a somewhat intimate neighboring milieu, one that was still tied up with the range of human vision.

On 16 November 1974, at a ceremony to mark the installation of a new reflector surface and a new powerful transmitter on the 305-meter Arecibo radio telescope in Puerto Rico, a so-called "Arecibo message" (Fig. 12.1) was sent to a star cluster named Messier 13 approximately 22,000 light years from Earth. As Carl Sagan and Frank Drake admit, the message "was not so much a serious effort at interstellar communication as a demonstration of the great powers that radio technology has put at our command" (Sagan et al. 1978, 24). If it reached its destination and someone actually replied, the reply would be received approximately 44,000 years after the original broadcast; we have to ignore the fact, however, that the destination will no longer be at its original location when the message arrives. The message—essentially a black-and-white television picture—took 169 seconds to send (when the transmission ended, the first bits were already passing through the orbit of Mars). It was sent via frequency-modulated radio waves in a binary code (as two tones, by switching the radio transmitter between two frequencies) and consisted of 1,679 bits that were meant to be arranged as a bitmap with 73 rows and 23 columns—the addressee is supposed to recognize that 1,679 is the multiple of these two prime numbers, and the bits need to be arranged in a rectangle to form the image. The content of the message consists of numbers from 1 to 10, atomic numbers of DNA components, molecular formulas of nucleotides, graphic representation of the double helix structure of DNA, a figure of a human being, and graphic renditions of the Solar System and the Arecibo radio telescope.

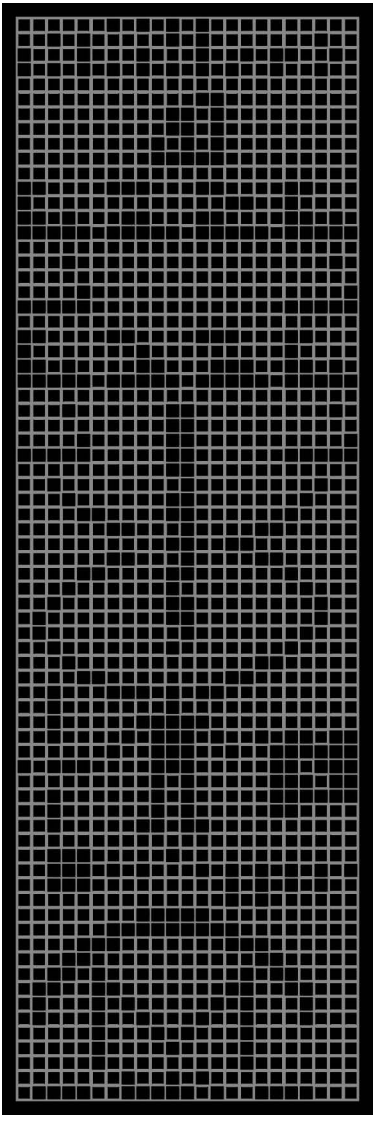

Figure 12.1: The decryption of the Arecibo message.

The radio telescopes in Arecibo and elsewhere are more commonly used for passive surveying of nearby stellar systems for signs of intelligent life rather than for actual messaging (even the idea for the Arecibo message originated from discussions of how to design a response if some signal from outer space was detected). The hope for extraterrestrial contact implies a certain asymmetry: the odds are much higher if we assume intelligence more advanced than us, just like Neovius or Galton did. Even though the messages are designed as intrinsically intelligible, they presuppose life forms very similar to ours and proceed from a communication model based on feedback and exchange. We should keep in mind that apart from these spectacular and, to say the least, sporadic acts of deliberate contact, humans have been transmitting radio signals to outer space since Marconi, or, to be more precise, radio and TV signals have been inadvertently leaking into outer space, forming an ever-expanding sphere around Earth with circa 100 light years radius by now. Large as this is, it is still negligible when compared to the size of our Galaxy.

It seems rather strange that once the technologies of observation (or communication) have shifted within the electromagnetic spectrum—from visible light to radio waves—we still keep thinking about them in optical terms and call the antennas used to receive radio waves "telescopes," tend to encrypt pictures as the preferred form of our messages, or call the data visualizations of space objects "photographs." The perceptual regime of radio telecommunication is, in fact, much closer to hearing than seeing (if we want to use a metaphorical description that can still be related to our sensory experience). More precisely, it is close to what is called overhearing. Overhearing is a strange case of auditory experience: it is neither hearing (a physiological phenomenon, an ability to perceive sounds), nor listening (a psychological act or process that can be developed into a complex technique). Overhearing marks a certain excess of hearing; it is an involuntary registering of a fragmentary pattern that attracts our attention while disturbing the borders of detached spaces—we typically overhear things that were not intended for us, from another room or from the conversation of strangers. Yet overhearing also differs from eavesdropping: it takes place non-intentionally, by accident or mistake, whenever sound leaks out of its proper place. Although the situation of overhearing requires both the "sender" and the "receiver" of the message, they are essentially disconnected and disengaged: the default mode is one of recording rather than of transmission, the infinite distance transforms reception into mere tracing, marking and detecting. As Peter Szendy notes (albeit in a very different context), overhearing is "impossible listening . . . something that is *possible only as impossible*" (2017, xii—emphasis PS).

## Space Fossils

Although radio waves are obviously the fastest and easiest way of sending a message to outer space, several physical objects were sent out as well. The first were the famous plaques affixed to Pioneer 10 and Pioneer 11, launched by NASA in 1972 and 1973 to study the environment around Jupiter and Saturn, the asteroid belt, solar winds and cosmic rays. These space probes were the first man-made objects to achieve the escape velocity that would allow them to leave the Solar system and travel at the speed of c. 11 km/s. The pair of gold-anodized aluminum plaques, attached to the probes' antenna support struts are 228.6 x 152.4 mm in size and feature an engraving of a schematic representation of male and female figures with the silhouette of the spacecraft behind them, to scale so that the size of human beings can be inferred by measuring the probe (Fig. 12.2).

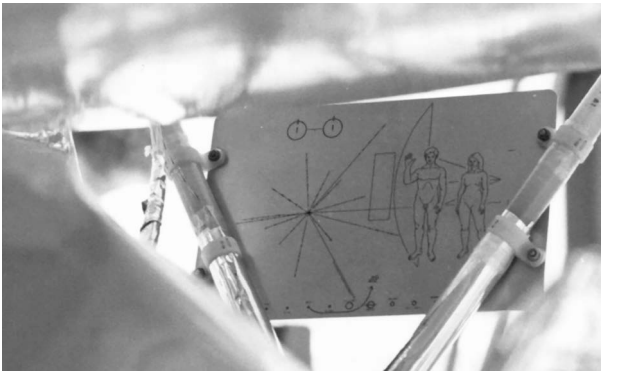

Figure 12.2: The Pioneer plaque.

The key to the message is a diagram of the hyperfine transition of hydrogen, the most abundant element in the universe. The spin-flip transition of a hydrogen atom produces microwave radiation, the period and wavelength of which establish units of time and length used as measurements in other symbols on the plaque. Simultaneously, this calls attention to what was thought to be the most promising frequency for interstellar messaging. The plaques also include two maps: one is a schematic diagram of the Solar System with the trajectory of the probe, the other a radial pattern of fifteen lines that correspond to the distance of the Sun from different pulsars and provide time signatures, making it possible to reconstruct the epoch in which the message was devised. The authors acknowledge the fact that there is only a negligible chance that the probes will penetrate the planetary system of a different civilization. But they find it possible "that some civilizations

far more advanced than ours have the means of detecting an object such as Pioneer 10 in interstellar space, distinguishing it from other objects of comparable size but not of artificial origin, and then intercepting and acquiring the spacecraft" (Sagan, Sagan, and Drake 1972, 881).

The hydrogen atom diagram and the pulsar map were reused for the Voyager Golden Records in 1977. Just like the older Pioneers, the Voyager probes' primary mission is to transmit scientific data—pictures and measurements—back to Earth. The Voyagers travel faster than the Pioneers and are currently monitoring conditions in the outer expanses of the Solar System. It is expected that in 2020, limited power will require their instruments to be gradually deactivated and their signal will blend into the noise of the surrounding universe. The mute probes will, however, continue their journey while carrying much more information than the Pioneer plaques. The records are also engraved, but this time data are physically etched into the record grooves. They contain a variety of sounds (collection of world music, greetings in 55 different languages, and sounds made by wind, surf, thunder, and animals) and 116 images encoded into a video signal (20 of them in color). Each image consists of 512 lines, giving a resolution slightly below that of analog television. Much has already been written on the selection of pictures on the records (diagrams and photographs, which are a mix of *National Geographic*, *The Family of Man* exhibition, and coffee table books on various themes from toys to animals and machines); details are provided by Jon Lomberg's chapter "Pictures of Earth" (in Sagan et al. 1978), I also recommend the remarkable three-volume photo book by Martin Eberle (2015), which covers the scientific background of the mission, compiles all the images present on the disc, and assembles images from the author's journey to the scientific institutions that still supervise the voyage.

I wish to focus instead on the various forms of images present, their relationships, and the overlaps employed in order to deliver an "intrinsically intelligible" message. The criterion for the picture selection was their "informative, not aesthetic, value" (Sagan et al. 1978, 154), which is one of the reasons why artworks were not included. Besides, these were omitted because they are reproductions and the extraterrestrials "would have enough trouble interpreting photographs of reality or simple diagrams without our including a photograph of a painting, which is itself an interpretation of reality" (Sagan et al. 1978, 153). Although the authors acknowledge that the notion of a picture is by no means universal even on Earth, they resort to photographs and technical illustrations as pre-symbolic, objective, mechanical forms of images. Such an understanding of photographic images was voiced, among others, by Rosalind Krauss in her article "Notes on the Index: Seventies Art in America," published in 1977, the year the Voyagers were launched. Krauss discusses the indexical relationship of a photograph to its object, which separates it from other, iconic images:

> Its separation from true icons is felt through the absoluteness of this physical genesis, one that seem to short-circuit or disallow those processes of schematization or symbolic intervention that operate within the graphic representation of most paintings. If the Symbolic finds its way into the pictorial art through the human consciousness operating behind the forms of representation, forming a connection between object and their meaning, this is not the case of photography. (Krauss 1985, 203)

The photographic image is, in other words, understood as the object itself, unmediated, uninterpreted and unschematized. This is obviously a very problematic assumption, revoked by many before and after Krauss, and the possibility of showing a photograph to an extraterrestrial (assuming it has some sense of vision) puts it to the test. Our conventional form of photographic representation does not result in any necessary way from the behavior of light or photochemical or photoelectric processes. It is a cultural artifact that employs a larger number of schematizations and symbolic interventions that became embodied in standardized image-making devices, norms and types of images and display, as well as protocols and techniques of seeing and looking. Every photographic image emerges from sedimented practices of measuring, scaling, grading, and calibrating. It seems only fitting, then, that the authors of the Voyager discs tried to devise various ways of helping the recipients understand how to see the pictures, or at least realize that they are looking at pictures: The first two reproduce objects that can be found elsewhere on the probe, namely engraved physically on the record's cover. Thus, the photograph can be compared with an object they can touch. The first image is a simple circle—basically a calibration image. The second one juxtaposes the pulsar map (also engraved on the cover) with a photograph of the Andromeda galaxy as a reference point, a landmark that the recipient might have seen. For similar reasons, several pictures of planets are included:

> Looking at objects that are at least somewhat familiar should help the recipients calibrate their system for reproducing pictures and understand our concept of a picture—how we represent reality on a two-dimensional surface. Certainly it will help them to see something familiar before moving on to those pictures of things that are totally unfamiliar to them. (Sagan et al. 1978, 188)

Showing familiar objects in the form of pictures amounts to teaching the meaning of images through a kind of ostension, a technique of pointing things out related to that employed in silhouettes of photographs: "It is a way of saying 'This is what we want you to see in this picture'" (Sagan et al. 1978, 156). The silhouette maximizes the contrast between the figure and its background and separates individual objects by means of outlines, thus focusing the viewer's attention on certain aspects of the image only, while ignoring other information it carries. Recurrent images or mo-

tifs were also used, especially humans, of course, in various situations, poses and perspectives (for example, in many of the pictures showing animals, humans are present observing or measuring them). Some of the images are superimposed with measurements and notations; all the photographs come naturally in the same size and resolution, whether they picture a galaxy or the fertilization of an egg. Among the first, "introductory" images, there are two dictionaries—one of mathematical definitions and one of physical unit definitions—defining symbols that provide contextual information on photographs and silhouettes, indicating the sizes and weights of objects or the durations of processes. In the form of photographs, objects' individual sizes are neutralized in a sense. But the very size of those photographs (and of the discs and plaques) is also determined by human somatic scale and the resolution of the human senses, and so presupposes an extraterrestrial receiver with a very similar makeup.

A number of entry points into the seemingly transparent photographic images needed to be introduced; the most important among them is on the cover of the gold-plated copper LP (Fig. 12.3).

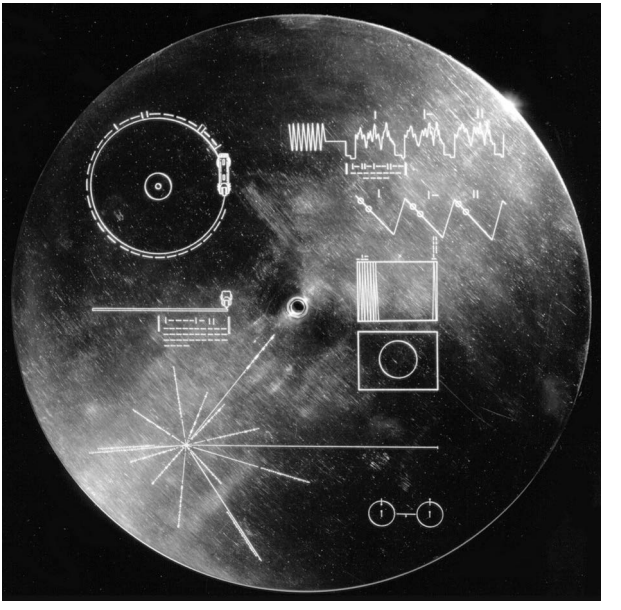

Figure 12.3: The Voyager Golden Record cover.

It provides operating instructions for playing back the disc and decoding the image data: before understanding the photographs, the extraterrestrials must un-

derstand the diagram that shows how the audio signal can be reconverted back into video. It utilizes the conventions of technical drawing and starts (if we read it from the upper left corner) with plan and elevation views of the disc and stylus, also indicating the proper speed to play the record. The NASA Jet Propulsion Laboratory webpage dedicated to Voyager calls it "an easily recognized drawing." The next diagram shows a graphic representation of the wave form of video signals, picture lines in binary numbers and the duration of one of the picture lines, the entire picture raster with 512 vertical lines in a complete picture, and a replica of the first picture on the record (the abovementioned circle) to verify that the signals have been correctly decoded.

The arrangement and logical order of images on the record imply that Sagan and his colleagues understood diagrams as more universal then photographs; diagrams provide the clues for reading photographs and also the very possibility of making them visible. They indicate the importance of an expert scientific and engineering visual culture, one that indulges in plans rather than in pictures: we often forget that to make a pretty picture using a camera, what we need is a diagrammatic plan to make the apparatus in the first place. Whereas pictures communicate some information about objects, plans are also used as means of construction, they are generative matrices used for designing, manufacturing and operating objects.

The authors understand diagrams as "scientific language," whereas photographs are cultural (in terms of content but not the medium itself). An exclusion of science, especially mathematics, from the realm of culture is evident throughout their writings; they ascribe to a Platonic conception of science, mingled with a firm belief in progress:

> [W]e might be able to communicate with representatives of . . . exotic civilizations, because they, like we, must come to grips with the same laws of physics and chemistry and astronomy. The composition of a star and its spectral properties are not fundamentally impositions that scientists have made on nature, but rather the other way around. There is an external reality that we ignore at our peril, and indeed much of the evolution of the human species can be described as an increasing concordance between the images within our brains and the reality in the external world. Thus, whatever the starting points, there must come to be a gradual convergence in intellectual content and discipline between diverse planetary species. (Sagan et al. 1978, 20)

Numbers, basic mathematical concepts and operations, as well as technical images are seen as a common idiom of universal communication and as a stamp of advanced intelligence towards which different worlds in their various stages inevitably gravitate. The prerequisite of the more or less simultaneous existence of a higher rationality somewhere in the universe is wishful thinking supposed to guarantee the ascending future of terrestrial rationality. It implicitly assumes that

scientific reasoning is a natural consequence of biological evolution; that the process of the development of life inevitably leads to the emergence of rationality, even if embodied in some nonhuman form, physiologically different yet with the same intelligence.

We have shifted significantly from the 1960s and 1970s discourses of the space race, the population explosion and Spaceship Earth grappling with the scaling of man to the planet and exposing the relationships between the parametric conditions of human life and planetary limits. The change in attitude in our "post-planetary" times (Parikka 2018) can be illustrated by another attempt at sending images to the cosmos, Trevor Paglen's artistic project *The Last Pictures* (2012). Paglen employs a similar strategy to the early space image-capsules while refuting some of their claims and assumptions. His micro-etched disc with one hundred photographs, encased in a gold-plated shell, was attached to a commercial communications satellite launched in 2012. The satellite will spend some fifteen years in a geostationary orbit, broadcasting television and internet signals before becoming another piece of space debris, orbiting the planet for several billion years. It is a time capsule rather than a voyager, a future ruin designed to outlast all life on the planet. The other main difference is in the selection of the one hundred last images: Paglen presents the darker side of humanity by including documents of war, poverty, inequality or destruction. His radical gesture is addressed to us, here and now, rather than to some future, other recipient; Paglen also published his project as a book and exhibited frequently. He does, however, employ identical visual strategy, a combination of photographs with a diagrammatic cover etching: "we use scientific concepts that we presume to be universal to communicate . . . ideas, . . . it seems reasonable to assume that the Artifact discoverers will be at least as technologically advanced as we are" (Paglen 2012, 177).

## Mysterious Messengers from the Real World

Although the prospect of extraterrestrial messaging has changed, from Neovius to Paglen, from a near-simultaneous "conversation" into dispatching deep-future time capsules, it remains committed to an anthropomorphic register of communication to a surprising degree. It presupposes that other species operate on the same somatic scale, know our science and mathematics, understand humanly standardized measurements, have senses, and obtain information primarily through the sense of sight, or can recognize images. Neovius was particularly influenced by Oersted's book *The Soul in Nature*, which claimed that the laws of nature hold throughout the universe: since the faculty of understanding and knowledge of rational beings is conditioned by the same physical nature everywhere, "this faculty must in its nature be everywhere the same" (Oersted 1852, 99). The assumption of

universal rationality and the progressive convergence of life and intelligence in the universe becomes more implicit in the late twentieth-century and contemporary projects. Nevertheless, it still exerts its influence and affects the choice of communication medium: the supposedly universal language of photography.

It seems to me that the most interesting challenge of these projects is not so much the content of their images and what is to be seen in them, but rather the problem of the "image" itself—the important question is not what kind of photographs should we address to extraterrestrials, but rather what might extraterrestrial photography look like. The prospect of deep future and the possibility of communicating with aliens is a radical act of imagination that decenters and unanchors humanity; if we are to communicate through images, we may as well start by decentering the notion of the image by embracing the universe itself as a maze of optical effects.

But perhaps one does not have to embark on a space voyage to encounter alien worlds. In 1963, Hannah Arendt participated in a symposium assembled to address the question "Has man's conquest of space increased or diminished his stature?" and opened her answer with the problem of understanding physical reality:

> The progress of modern science has demonstrated very forcefully to what an extent this observed universe, the infinitely small no less than the infinitely large, escapes not only the coarseness of human sense perception but even the enormously ingenious instruments that have been built for its refinement. The phenomena with which modern physical research is concerned turn up like "mysterious messenger[s] from the real world," according to Max Planck in *The Universe in the Light of Modern Physics*, and we know no more about them than that they affect our measuring instruments in a certain way, suspecting all the while with Eddington that "the former have as much resemblance to the latter as a telephone number has to a subscriber." (Arendt 1963, 528)

Referring specifically to the generation of Einstein, Planck, Bohr or Schrödinger, Arendt notes their discovery that the universe they have tried to conquer is inherently inaccessible, unthinkable, and incomprehensible by the human mind: the categories of human reason have their ultimate source in the earth-bound human senses, which have become detached from the physical world of science, and we may well apply quite different types of natural laws to one and the same physical event. The methods of scientific imaging, which detect, sense, and observe—"overhear"—macroscopic or massively distributed objects, as well as extremely fast or slow-moving events conjure up images rarely coextensive with human vision and point out what extraterrestrial images might actually look like.[1]

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## Notes

1 This work was supported by project 19-26865X "Operational Images and Visual Culture: Media Archeological Investigations" funded by the Czech Science Foundation.

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TV-Serie Downton Abbey." In *SPIEL. Eine Zeitschrift für Medienkultur* (2016): 67-84; *Revolutionsfotografie im 20. Jahrhundert—Zwischen Dokumentation, Agitation und Memoration* (Cologne: Herbert von Halem 2019).

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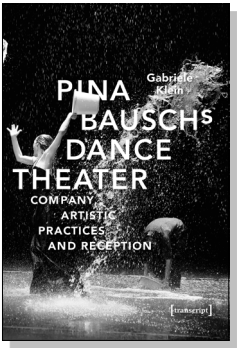


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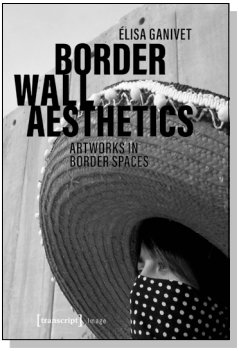


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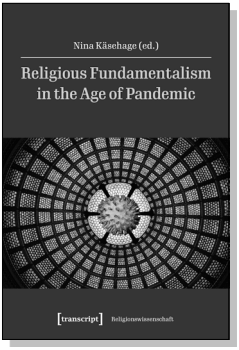


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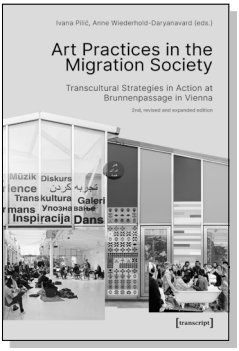


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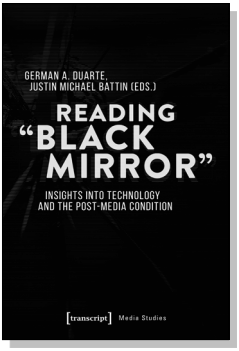


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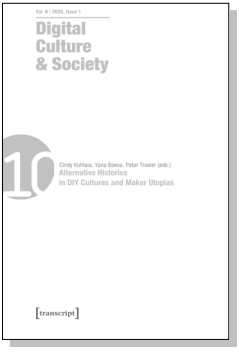


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