

Computational Photography as a Material-Discursive Practice

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Cameras are black boxes – in two senses. In analog photography they have to be light-proof in order to protect the contained photochemical material from any unwanted and that means undirected exposure. But in scholarly research on photography the camera likewise is usually not opened and analyzed in its evolving technical details. It is the photographs themselves that are at the center of interest.

Even somebody like Vilém Flusser, who has acknowledged the relevance of the apparatus, does so in an ahistoric and rather unspecific manner. There remains a tension between technology and functionality, between the inside and the outside of the black box, that Flusser deliberately addresses in what might be one of the most concise descriptions of the photographic apparatus when he writes: “The camera is a structurally complex, but functionally simple, plaything.” ([1983] 2000, 57) He then elaborates how the photo amateur (unlike the serious photographer), is lured into the pleasurable combination of *knowing* about the complexity of her apparatus and concurrently *using* it with ease. However, Flusser himself, in his interest for the photographic gesture, then decides to concentrate on the functionality, ignore the complexity, and regard the camera as a conceptual and not as a technical object. He thus follows the amateur and makes him the guiding figure of his phenomenological culture theory.

When Flusser writes his *Towards a Philosophy of Photography* in the early 1980s, he can look back at nearly 150 years of a relatively stable technology. Digital photography already existed but had not yet left the labs and therefore had no practical relevance. This, as we all know, has changed since the 1990s. Cameras are no longer stable objects and the very amount of steadily introduced new camera models can be seen as a constant need to reaffirm the concept of the camera as such. On the other hand, the transition from analog to digital cameras has been understood as one that changes the

‘nature’ of the picture, its substance, where every picture element, or pixel for short, becomes an addressable unit (e.g. Mitchell 1992; Manovich 2001). In my paper, I want to suggest replacing this ontological understanding of the recent changes with an operational one and will speak of computational rather than digital photography. Such a proposal also asks for alternative methods for investigating apparatuses like the camera.

But first let’s try to answer the question what computational photography is. The term usually refers to digital processing of image data inside the camera. It thus signifies a shift from the post-production options that became available with and where discussed in the context of the emergence of digital photography in the 1990s towards automated image processing during the actual shooting. With this automation also comes a transfer from decisions being made by humans to decisions being made by the camera itself. The respective software and dedicated hardware components, of course, were at some point conceived by humans but as not only the field of machine learning has shown, the borders between humans and machines appear more diaphanous today than ever. It thus makes sense to speak of joint agency of humans and non-humans as suggested by actor-network theory (Latour 1991; 1999).

Engineers working on computational photography have developed a canon of applications that mostly follow the idea of image improvements. Essential and widespread applications are:

- High Dynamic Range (HDR) algorithms that overcome limitations in reproducible contrast by combining several exposures with varying stops.
- The flash/no-flash method merges two images with ambient and flash light to capture a wider range of illumination.
- Panorama stitching, finally, overcomes limitations of the camera’s field of view by combining shots made in different directions. (Hayes 2008)

What most applications of computational photography have in common is the usage of several exposures. As I have shown in an earlier paper, the employment of multiple views undermines the previously fundamental relevance of a defined and usually human standpoint (Weiberg 2017). This precondition of computational photography is easily overlooked if one only asks who makes decisions within the technique. But here I want to address another change that comes with computational photography: The blurring of hardware and software, of machinic and human agency likewise signifies a blending of matter and meaning. Digitization was initially understood as a translation of matter into signs but meanwhile we have started to understand that the digital has its own material constraints and cannot be seen as a purely semantic but also as a material domain.

The distinction between matter and meaning belongs to the many dichotomies that were introduced with the enlightenment since the 17th century and that have been questioned by science scholars in recent years (Latour 1993; Rheinberger 2002). The history of science in general is a rich source for photo theory as it deals with the same issues of epistemology and representationalism and in my opinion has not yet received the attention from photography scholars it would deserve. Likewise, the field of new materialism (Coole and Frost 2010; Dolphijn and Tuin 2012), which tries to rethink our understanding of matter and its forms of agency, can be helpful for developing alternative approaches to photography.

The physicist Karen Barad does not define herself as a new materialist, though her work is discussed in this context. I want to suggest Barad's concept of material-discursive practices to bridge the gap between the two domains of matter and meaning in regard to computational photography. In her seminal book *Meeting the Universe Halfway* (2007), Barad develops her theory of agential realism, which draws on such distinct references as the quantum physics of Niels Bohr and the feminist performativity concept of Judith Butler. Barad is interested in how Bohr's careful analysis of measurement in science, a practice that we can compare to that of photography, leads him to reject representationalism. (Light in physics can be either understood as continuous waves or as discrete particles. Both models contradict each other and require distinct methods of measurement.) The conclusion that Barad draws from this and that might be counter-intuitive at first sight is not to fall into the unproductive trap of social constructivism, where signs ultimately win over matter, but rather to understand Bohr, his instruments and the subjects of his research as entities that constitute each other. In Barad's terminology they do not *interact* as self-sufficient entities, they *intra-act* and thereby (re)define each other. And it is this assumption that not only hardware and software but also photographer and subject have no stable identities that allows us to develop a different understanding of photographic practices.

In the scope of this paper, of course, I cannot discuss Barad in detail and instead I want to elaborate on one point that I think is relevant for us here in regard to what implications her writings might have for our understanding of photography. Explaining Bohr's position on the dynamism of matter, Barad writes: "Moving away from the representationalist trap of geometrical optics, I shift the focus to physical optics, to questions of diffraction rather than reflection." (2007, 135) I will come back to the question of diffraction but first have to talk about the critique of geometrical optics. Critical, apparatus orientated photographic practices likewise often deal with geometry not only as an apparent basis for photography but also as a source of delusions. Such practices have existed for a long time but have gained a new momentum since the digitization of photography in the 1990s.

Exemplary for the survey of geometry as a basis for photography are the camera ob-

scura installations by Zoe Leonard. In 2011, the artist began a series of such installations that confront the geometry of the optics with the specific geometry of the different spaces she used. On the one hand, she brings us back to the very beginning of photography when images could not yet be preserved. On the other hand, these installations have a very post-photographic character being produced after Leonard herself had temporally abandoned the production of photographic images (Fiske 2012). The images one encounters inside her camera obscuras are ephemeral, fragile, and also function as a light source for the room itself and thus question widespread photographic concepts.

The Israeli artist and theoretician Aïm Deüelle Lüschi has constructed cameras as a critique of visual representations in the context of the political situation in the Middle East. His view-finder-less cameras document the convergence of various entities in a shared space while evading any purposeful and thus hegemonic visual representation. With his somewhat kaleidoscopic images Deüelle Lüschi literally replaces reflections with diffractions, a step not only requested by Barad (2007, 29) but also by Donna Haraway ([1992] 2004, 70) from whom she adopts this notion. Deüelle Lüschi describes his practice as “distracted concentration” (in Azoulay 2014, 235), a mode of perception that is still understood in relation to human consciousness where for Haraway and Barad neither the origin nor the target of light are fixed.

What makes Deüelle Lüschi, who works only with traditional, analog techniques, interesting in regard to computational photography is that he conceives the body of the camera as a threshold, a place where light turns into matter. What he strives for is delaying, nearly preventing the materialization of an image in what he calls “the ‘struggle’ inside the camera obscura and upon the emulsion surface” (in Azoulay 2014, 238). The camera itself has turned into a discursive device, a phenomenon that also became more relevant with computational photography but remains difficult to grasp. The images of computational photography are figurative but can only be regarded as representational with a very open understanding of what they represent - subjects, expectations, norms, the technology itself or the threshold Deüelle Lüschi addresses. Between reality and an image, we now find raw data that is as inaccessible as the atoms of Niels Bohr.

Like other aspects of computational photography, raw data features structural similarities to phenomena of older photographic dispositifs and that suggest comparisons such as in this case with latent photochemical images. Both require an active interpretation to be ‘useful’ as Barad has described it in regard to the measuring practices of Bohr. What is new with computational photography is the degree of automation in this interpretative step that encourages to collect and access much larger amounts of intermediary entities. This becomes evident when we look at a technique that is called

‘flutter shutter’ and that can be used to reduce motion blur caused by relative movement between a camera and one or more of its subjects. In analog photography there are basically two options to avoid this usually unwanted effect: we can reduce either the relative movement or the duration of exposure. Computational photography, however, provides an option that seems counter-intuitive on first sight: the camera collects several images in random intervals with different exposure times and then infers a relatively sharp images from them (Agrawal 2014). The fact that the images feature different degrees of motion blur means that those that are less sharp are deliberately out of focus. But the comparison between the images allows the software to ascertain the relative motion that caused the problem. It knows something about the situation the camera sees and compensates for the shortcomings of the hardware.

Such a technical ‘awareness’ of the situation was originally conceived by the inventors of cybernetics in the 1940s to improve the ability of missiles to hit moving targets. I am not pointing to this genealogy to suggest that computational photography per se is a military technology but rather because the cybernetic feedback structures constantly oscillate between software and hardware, between signs and matter and thus circumvent any determination of primary agency on either side. The camera here is a device that persistently measures but is also measured in order to adjust its measurement values. This ceaseless repetition that manifests in its performativity is something that Barad also finds in Butler’s conception of gendering as a reiteration and potential modification of norms (Barad 2007, 57).

Here I want to come back to Barad’s distinction between geometrical and physical optics and to the shift from reflection to diffraction. (Barad uses the latter term in the same sense as the more common term interference.) This shift is caused by different instruments or operations that are used to observe a phenomenon. “In contrast to reflecting apparatuses, like mirrors, which produce images – more or less faithful – of objects placed a distance from the mirror, diffraction gratings are instruments that produce patterns that mark differences in the relative characters (i.e., amplitude and phase) of individual waves as they combine.” (2007, 81) So while a reflection produces an analogon, a representation by means of similarity, diffraction creates complex patterns that are jointly caused by an instrument and its subject.

Optical instruments as epistemic devices (and photographic cameras are but one offspring of this larger trajectory) with their origin in the European 17th century had one comprehensive goal: to create distance between observer and observed for the sake of objectivity. Whether such distances can and should exist has been matter of debate in one form or the other. Hito Steyerl (2014), when writing about computational photography, has suggested to see its intermediary processes as proxies. These proxies for Steyerl are considered subject-matter of critical inquiries because they might be

informed by economic or political interests. Such a critical discourse, however, necessarily perpetuates the very idea of representation and of a proper closure of the gap between matter and sign. Barad and other critics of modernism, on the other hand, simply claim that originally there is no distance to be bridged. As photography has been a vital contributor of constructing such distances, one question to be answered is how studies of cameras as non-distancing devices can look like. Though I cannot answer this question today, I want to shortly elaborate on it with an example from the field of computational photography: Smile detection enables a camera to trigger an exposure automatically once it recognizes that the subject lifts the corners of her mouth. We can read the resulting image as the representation of a smile or even of a happy person. We can read it as the representation of an either social or aesthetic convention, which has found its way into software. Or we can understand it as an ever-evolving circle of causes with liminal modifications where effective factors have to be traced in between material and discursive domains.

This is the conclusion that Barad draws from Bohr that the challenge is not an epistemological but an ontological one. “For Bohr, what is at issue is not that we cannot *know* both the position and momentum of a particle simultaneously (as Heisenberg initially argued), but rather that particles do not *have* determinate values of position and momentum simultaneously.” (2007, 19) Beyond the specific subject of quantum physics Barad’s point is that from it one can infer a general methodology. “A performative understanding of scientific practices” – and as stated before I identify these with photographic ones – “takes account of the fact that knowing does not come from standing at a distance and representing but rather from *a direct material engagement with the world*.” (2007, 49) Identities thus are not recognized and represented but the result of repetitions and variations.

A conclusion I want to propose is not limited to computational photography but rather takes this most recent development as a starting point to read photography in a different way. From this perspective photography has first been chemical, then optical and now computational. The changing identities of photography herein are not simply ontological transformations but also different modes of perceiving the medium. The optical has dominated our understanding of photography with metaphors such as mirror or window borrowed from fine arts. It is analog not only in a technical but also in a conceptual sense. The diffractive methodology that Barad has suggested, “a way of attending to entanglements in reading important insights and approaches through one another” (2007, 30), might also be used to research photography if we consider photography as a practice that is a diffractive entanglement itself. Can we understand the camera as a diffractor and what do we win with it? Distortion would be an integral part of photography and not a defect of an otherwise ideal mirror. Different results from different apparatuses do not lead to uncertainty but complementarity. Any kind of translation, the proxies Steyerl writes about, does not estrange us from a situation

but brings all its relata closer together. “Images or representations are not snapshots or depictions of what awaits us but rather condensations or traces of multiple practices of engagement.” (Barad 2007, 53)

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