

True colors: chromaticity, realism and technological honesty

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True Colors: Chromaticity, Realism and Technological Honesty

I propose an application of agential realism to my practice as research, a film about my mother getting one tattoo covered with a new one, to investigate the material-discursive role played by the camera in determining meaning within the film image. I use my practice as a comparative case study, considering how a specific camera apparatus determines and negotiates standards of colour accuracy, and what it means to remove those colour values in post-production. I argue that the different colour processing of the same footage produces perceptible onto-epistemological difference, even while it remains indexically equivalent. Second, I will show exactly how this particular digital photosensitive technology meets the pro-filmic event to record colour, enacting agencies that reduce matter to fit a specifically programmed colour system, prior to any manipulation in post-production. The system itself draws the boundaries of accuracy it claims to achieve, with inevitable ethical implications.

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A.I. Philip is a PhD researcher, practitioner and sessional lecturer at the University of Reading. His research attempts to diffract cinematic realism through agential realism, as developed by Karen Barad. He is currently producing a series of essay films as part of his doctoral research, co-supervised by Professors Lúcia Nagib and Cecília Mello. He has over twenty years' experience working in the private sector in London and New York, producing, editing and animating films.

“I think black-and-white photographs have more character, more life.” My mother made this statement to my sister as I filmed them in the waiting room of a tattoo parlor in Salt Lake City, Utah, in 2010. My mother, Regina, was about to have a new tattoo, her first inked in color, inscribed over an existing one she no longer liked. In an audio interview recorded two years later, unhappy with the new tattoo, she repeated her preference for the monochromatic, equating it to a favorable experience of reality: “one thing I like is black-and-white tattoos. [...] Actually, I like life to be black-and-white” (*We Tattooed Your Mother*, Andrew I. Philip, 2021).

I am making a film based on this shoot and the proceeding interview two years later, as well as footage and audio yet to be recorded. This practice functions as a research testing ground to explore the entangled agencies enacted by the camera in the determination of cinematic realism, and the ethical implications therein. In the film, my mother’s comments trigger a shift from color to monochromatic images. On a conventional, literal level, this transition defers to her words by materializing her desire for “life to be in black and in white.” But what meaning, if any, is activated by this technical operation? André Bazin suggests that a photographed object is ontologically identical to its referent regardless of being recorded in color or black-and-white (2005, 98). There are various ways to represent the same object, he says: “each representation discards or retains various of the qualities that permit us to recognize the object on the screen” (2005, 27). Does the in-sequence desaturation of a shot in post-production therefore in no way change the material meaning of the recorded object, beyond its recognition as an object? Does the technical accuracy of the recording shift because color values have been subtracted? Can such

questions be objectively measured?

By addressing these queries, I aim to sketch out a practical application of Karen Barad’s “agential realism” (2007) that investigates the material-discursive role played by the camera in determining meaning within the film image. Barad argues that being and knowing are inseparable: every phenomenon is meaningfully material-discursive by default, making this an inextricably onto-epistemological account of the universe, with corresponding ethical implications. Barad is not a film theorist. However, I propose that engaging with film practice through agential realism generates opportunities to contemplate the meaningful activations enacted by certain technical functions of cinematography. These remain an indivisible, but often seemingly indiscernible aspect of the event on screen. For this article, I will use my practice as a comparative case study to consider how a specific camera apparatus determines and negotiates standards of color accuracy, and what it means to remove those color values in post-production. Using a single still frame adjusted in color grading software, I will compare the shift in computational color values within the contextual techno-cultural color system that produces them. In the first instance, I argue that the different color processing of the same footage produces perceptible onto-epistemological difference, even while it remains indexically equivalent. Second, I will show exactly how this particular digital photosensitive technology meets the pro-filmic event to record color, enacting agencies that reduce matter to fit a specifically programmed color system, prior to any manipulation in post-production. The system itself draws the boundaries of accuracy it claims to achieve, with inevitable ethical implications. While the filmed object might be transcendently conceived

to be ontologically identical regardless of the recording apparatus, I contend that in the determinate reality of the technical image it is always already meaningful, as Vilém Flusser has also argued (2011, 41).

I do not wish to minimize the importance of the pro-filmic event by over-determining in favor of the camera, but rather to highlight some of the “technological specificities” (Parikka 2012, 96) that draw material boundaries within the image in ways that are sensed, but that defy language. As Laura Mulvey points out in reference to photography, but equally applicable here: “there is the ‘intellectual impossibility’ of reducing the photograph to language and a grammatical system of meaning” (2006, 63). Material-discursive practices are difficult to verbalize, and will certainly never be universal for every filmmaker, theorist or spectator. Nonetheless, certain scientific facts can be established within their technical context, highlighting some of the “categories” designed into the camera that program the gestures of the operator (Flusser 1984, 22) to create the conditions for the specific reality generated on screen.

I begin with a brief overview of “agential realism” and my proposed adaptation to film practices. I will outline how color functions as a superlative example of entangled agencies generating meaningful phenomena, and how in technical images, color or black-and-white footage ineluctably entangles the discursive-materiality of the pro-filmic event. I describe my practice as research methodology within a closed loop of production, theory, close analysis and re-production, to generate further connections that can feed back into theoretical considerations. For this case study, I break down the subtractive process of recording color in-camera, followed by the subtraction

of color saturation from footage in post-production to outline precisely what recorded data is lost, if any. The motivation here is to consider the specific techno-scientific arrangement of the camera’s “rigorous determinism” (Bazin 1958, 15, my translation¹) that enables the recording of color in this particular pro-filmic scene. I conclude that while footage presented either in color or in black-and-white can evoke varying spectatorial significance, the image is already materially-discursive to begin with, requiring this filmmaker to take responsibility for that particular meaning. I argue that this transition between color and monochrome within a sequence generates a certain technological honesty (as proffered by Coates 2010, 13), a renegotiation of documentary footage that foregrounds the role of the recording apparatus in the determination of cinematic realism. While I see this research as reasonably distinctive from the flourishing field of research around the history of color in cinema, including work by Sarah Street, Kirsty Sinclair Dootson, Joshua Yumibe and Paul Coates, I refer to a selection of these studies throughout.

In living color: Agential realism, intra-actions and the apparatus

Karen Barad argues that the constant, dynamic performativity of the universe and our place within it create a foundational problem for Newtonian notions of objectivity and causality. The tendency to neatly separate the world into any number of Cartesian dualities assumes the possibility of observing the universe from an exterior perspective. Inspired by studies in quantum physics, Barad proposes that all matter is performative: a perpetual, generative *enactment* of change upon other matter (2007, 170). This notion of enactment forms the backbone to Barad’s reformulation of agency, expanding it from the classically understood definition of an individual

human's "capacity to act" (Ahearn 2001, 112). Troubling the anthropocentric, simplistic dualisms of cause-and-effect between subject-object, for Barad agency is less a property that belongs to a pre-given (human) entity, and more of an energetic action in the meeting between different matter through which each entity is enacted. Rather than a fixed capacity some ascribed subject or object inherently *has*, agency is what matter, human and non-human, *does* within each unique dynamic encounter (2007, 178). Barad proposes that how we observe the world from within it, including our instruments of observation, always performs agential change, entangling with other agencies to enact the observed phenomenon. Phenomena emerge from the *intra-action* of matter being observed and the material observing apparatus (as opposed to interaction, which presupposes the existence of distinct entities before this encounter). The specificity of experimental conditions draws the boundaries of particular scientific outcomes, meaning that how we understand the world is mutually articulated by the matter being measured and the measuring matter (2007, 152).

Color demonstrates intra-action in practice. Neither a purely phenomenological experience nor easily defined as a property of nature, color emerges in the meeting of a visual system and reflected, refracted, and diffracted light. The visible spectrum refers to the determination of wavelengths perceptible to human beings, a small range within the established gamut of electromagnetic radiation. In other words, the *visible* aspect of the spectrum implies *visible to humans*, rather than a purely exterior phenomenon. The very determination of light as a wave is complicated by wave-particle duality, a paradox giving rise to the field of quantum physics. Simply put, measured one way, light

behaves as a particle; measured another, it displays wave-like patterns. Classical physics cannot account for this contradiction, as a particle refers to a point of matter in space, whereas a wave is understood as turbulence in a field of matter; a phenomenon cannot be both at the same time. To account for this conundrum, pioneering quantum physicist Niels Bohr proposed that experimental conditions play a *complementary* role in generating particular results, thus rejecting the mechanistic cause-and-effect account of the universe described by classical physics. The visible spectrum, therefore, emerges from specific conditions whereupon one type of matter (light) makes itself intelligible to another (a visual system). Matter intra-acts with other matter to enact what we identify as the visible spectrum, rather than either one pre-determining the other, an "entanglement of matter and meaning" (Barad 2007). Sean Cubitt suggests that: "the division of subject from object, which so deeply characterizes the Western tradition, does not obtain in the case of color. Neither produced by us alone nor an exclusive property of the world, it belongs to the intersection, the *mutual greeting* of human and universe" (2014, 112, my emphasis). It is this mutual greeting, this meeting of the universe halfway, that Barad terms "agential realism."

What then, is the difference between realism and reality? For Barad, reality is enacted through every intra-active phenomenon. It follows that what appears on screen is a specific enactment of reality. Realism, both in cinema and for Barad, is a commitment to the notion that "how reality is understood matters" (2007, 205). However, to define a universal, fixed reality means somehow encompassing all possible and potential intra-actions, an effectively infinite and ever-changing quantity. This does not imply a transcendental or unknowable

reality, but rather that a universal notion of reality, like color, is rendered indeterminate through its very potential for agential enactments, emerging immanently by and through intra-actions. This account refuses reductive, rigid definitions of the real, attending instead to the inescapable, dynamic complexities involved in the specificity of each material encounter, and crucially removing humans from the center of these encounters. Barad's approach is resolutely political, feminist, and ethical as well as scientifically grounded. Agential realism incorporates the indeterminate, non-human, vigorous multiplicity of the universe, and the insufficiency of any singular grand narrative, anthropocentrically patriarchal or otherwise, to fully encompass the near infinite potential probabilities of material encounters. However, in Barad's own words: "The existence of indeterminacies does not mean that there are no facts, no histories, no bleeding – on the contrary, indeterminacies are constitutive of the very materiality of being, and some of us live with our pain, pleasure, and also political courage..." (2014, 178).

Any absolutist determination is a drawing of specific boundaries that do not necessarily inhere prior to that determination and is "materially haunted by – infused with – that which is constitutively excluded" (2014, 178). The ethics in the onto-epistemological approach proposed by Barad aim to address the exclusions in any knowledge-making practices. And it is here that I find the relevance to my filmic approach, one that attempts to take responsibility for my filmmaking practice materializing the world in particular ways. I aim to entangle the technical "exclusions and effacements" (Lyotard 1986, 353) inherent in the making of films by finding ways to include them, highlighting their agential role in the enactment of reality on screen. By doing this, I am adapting

the ethical underpinning of Barad's theories with my reading of André Bazin, expanding both by entangling the agencies of the recording apparatus into a personal agential realist filmmaking approach.

It is worth noting that I do not intend to discredit or critique Bazin; on the contrary, his always carefully considered reasoning seems endlessly adaptable, which is why his theories continue to persist so long after his untimely death. As a filmmaker, I share his enthusiasm for the creative possibilities of cinema's relationship to reality, as well as the responsibility that comes with that relationship, leading me to ponder these technical questions. Bazin's enduring argument is that the use of long takes and deep focus maximize the potential intrusion of dynamically indeterminate reality in the enclosed, determined world of the narrative. Bazin suggests that cinema blurs the line between object and subject. Reality is "multiple and full of ambiguity" (2005, 37). The unity of the world on film is necessarily "refracted" through the aesthetic consciousness of the filmmaker, "a mental landscape at once as objective as a straight photograph and as subjective as pure personal consciousness" (2005, 98). He famously ends his seminal vindication of the objective properties of photography by admitting that "cinema is also a language" (1967, 16). In my view, Bazin suggests in these qualifications an awareness of the anthropocentric discursivity inherently built-in to filmmaking practice—not necessarily in *what* it records, but in *how* it records it. His ambivalence to color in film also nods to this; he claims that painting remains superior to photography in its objectively subjective expression of color (1967, 12). His defense of realism acknowledges this tension, proposing that the only honest approach, always limited by the primacy of the narrative and the artifice of the artform, works

hard to counteract the manipulative discursivity intrinsic to filmmaking. A filmmaker achieves this by presenting a unified, unfragmented, believable respect for reality, regardless of genre.

I argue that Bazin's suggestion that any photographic camera produces "objectivity in time" (1967, 14) needs some expansion to include the recording instrument within that objectivity. The indexical, an impression or trace of reality (Wollen 1969), can undeniably be registered via various photographic practices. Nonetheless, given enough time to plan, a filmmaker chooses specific equipment to tell a particular story—including how it records color. After Bohr and Barad, the experimental conditions form an indivisible part of the enactment of phenomena. The recording of the dynamism of the pro-filmic event by the camera apparatus performs an "agential cut" in the world, an objective measurement within the parameters of those specific material conditions (2007, 148). As such, any apparatus assembled to observe the world in a particular way must be considered an integral part of how that reality is enacted.

The cine camera does not spring "full blown from the head of Zeus" (Barad 2007, 144), ready to reproduce color as it inherently exists. The historicity and culture of any mechanical or technological apparatus, designed within specific techno-cultural environments, articulates particular performative processes. Each camera assemblage (format, lens, technical configuration, etc.) enacts a different meaning to the indexical, generating a material-discursive reality. In her taxonomy of cinematic realism, Lúcia Nagib categorizes the cinematographic apparatus as a "mode of address" (2020, 28), that is to say, a stylistic, presentational choice that functions with a qualified distinction from the "mode of production." The recording of color would be included in the former category. In the latter, Nagib locates a

"physical engagement" with the pro-filmic event. She qualifies that these modes are "entwined and mutually dependent" (2020, 27), and it is precisely in this entanglement where we find the "agential cut" that, as Barad puts it: "enacts a resolution *within* the phenomenon of the inherent ontological (and semantic) indeterminacy" (2007, 140). A film shot slices through all the potential, virtual possibilities of reality, to entangle into an actualized one. What occurs in the pro-filmic timespace evidently matters enormously; less apparent is how the functions taking place within the filming apparatus co-constitute the meaning of those events. The mutual dependency and entanglement of these two performative cinematic practices are all that is left of the ephemeral event itself, a recording that *resolves the indeterminacy of the real into a determinate, reproducible, material-discursive enactment of reality*. How color is resolved on film depends upon the standards of accuracy defined by each camera rather than simply inhering in the natural world, with consequential determinations of meaning—scientific, aesthetic, cultural, and political—within the shot.

Bleeding colors: Chromatic contexts

When Jacques Rancière describes his work as "indisciplinary," he could be talking about color: "it is not only a matter of going besides the disciplines but of breaking them" (quoted in Baronian & Rosello 2008, 1–2). Color blurs the boundaries of science, technology, philosophy, religion, art criticism, popular culture, critical theory, and creative practice. From Newton to Goethe and many more since and in between, science and philosophy have struggled to define color as either an inherent quality of nature or an embodied perception; color resists being fixed in place. Indeed, Sarah Street claims that in cinema even "the history of color is a living thing as

we balance evidence of contemporary reactions on first release against our own perceptions” (2012b, 210). The study of color in film has generated fruitful output, as historiographies of color’s industrialization weave in the manifold techno-cultural threads of modernism, post-modernism and post-colonialism intertwining through our digital present. Joshua Yumibe, in his study of early cinema color tinting practices, goes so far as to say that “color perception and the issues it raises about sensory experience are central to the history of cinema” (2012, 9). For this article, I take a leaf from Edward Branigan’s recent Wittgensteinian “tracking” of color in cinema and art: “In thinking about color today, perhaps one should pause between positive and negative assessments in order to simply untangle *which contextual elements* are being selected to *blend with color* in order to interpret its general nature and function. How is color being colored?” (2018, 106).

The instruments used to record and process color in the images being analyzed make up the contextual elements within this study, as well as the material significance of removing color from technical images. It is worth briefly summarizing the circumstances giving rise to the film and my approach to this practical research. The footage comes from the largely unplanned shoot of my mother in the tattoo parlor. The details pertaining to how we got to that place at that time remains a disputed issue among those who were present. What can be ascertained is that I shot just under 42 minutes of footage. The metadata encoded in the original rushes verify that the first shot was taken roughly two hours before the last. I used the camera I had with me: a Canon EOS 7D Digital SLR and the zoom lens that came as part of the camera kit, a Canon EF-S 18-135mm. My Brazilian mother and I were visiting my sister Libby at

her home in Utah; at some point, my mother told us she disliked the tattoo on her left shoulder and wanted to cover it with a new one, leading to the idea of filming the process. My mother’s original tattoo, one of nine at the time, was an unidentifiable winged insect inscribed with the names of her four grandchildren. I filmed as a new tattoo, a blue butterfly, was superimposed while my sister and her daughter watched, footage that remained largely untouched for ten years. Contemplating the pivotal implications of Barad’s work for film and screen studies, I decided to use the archived images as my research praxis.

Rather than charting an *a posteriori* rational reconstruction of a body of finished professional work as a source of data, as proposed by Desmond Bell (2001), my practical methodology is processual and remains open to change. By considering theoretical and practical ramifications as well as productive possibilities that might be folded back into the work, the film becomes a ground for experimentation, “an exploration and testing of ideas about the medium, its creative capacities and its mode of public address” (Bell 2001, 4). To produce small, personal films in this way presents a controlled practical opportunity for renegotiating the complexities of the technical cinematographic apparatus and its encounter with the pro-filmic event. Praxis affords experimentation beyond the page, which in turn feeds back into theory. Instead of constructing a generically passive spectator, as has been the burden of apparatus theory in the past, I propose a closed loop: a film made by me, about me (through my mother), and for my own research, although I will also screen it more widely at a later date. By experimenting with modes of address, I create a shifting filmic text I can subsequently closely analyze, with resulting conclusions or questions folded back into the film.

My mother's metaphorical preference for a "life in black-and-white" narratively triggers a transition into monochrome images. By comparing two stills from the footage (Figs. 1 and 2), we can confirm that the indexicality of the footage remains identical, but the noticeable change in the image shifts the mode of address. But what else might this transition signify? There are no definitive answers. David Batchelor's *Chromophobia* (2000) proposes that color has been the subject of disdain for European philosophers and artists at least since Plato, variously dismissed as primitively foreign, seductively feminine, or dangerously queer. Might my mother's preference be due to an inherited Aristotelean aesthetics of line over color, *disegno versus colore* (Batchelor 2000, 53)? This seems the case when it comes to her tattoos. By "black-and-white tattoos," she implies black ink outlines inscribed against "white" skin; hers is incidentally closer to brown although she is officially classed white in Brazil. When she talks about "life in black-and-white," however, what might she mean? My mother is no minimalist: given the choice, she prefers bright red cars, her favorite color. She once dyed a rebellious streak of shocking pink in her short-cropped salt and pepper hair. She may not fit normative conventions of Brazilian femininity, but neither is she an austere modernist who avoids color. Even her beloved football clubs, São Paulo FC and Rio's Fluminense, have tricolor shirts, as opposed to Corinthians, who she reviles, in their black-and-white strip. Her visual life is phenomenologically in color, having never worn glasses in her youth or having been diagnosed with color blindness. Whatever this stated preference for monochrome might involve, it is not a simple Euro-centric cultural rejection of vulgar, feminine or queer color as elaborated by Batchelor. What she might be alluding to is the presumed simplification of life in black-and-white.

Street photographer Joel Meyerowitz defended his shift from black-and-white to color film, against the grain of the 1970s New York art world's chromophobic snobbishness, by suggesting: "all a camera does, it describes what's in front of the camera when you press the button. I thought: If description is what it's all about, black-and-white description is half of what color description is" (quoted in Walker 2013, 2). Perhaps a halving of description, of discourse, of expression, is the appeal of "life in black-and-white." Wim Wenders submits, in his film about a film *The State of Things* (*Der Stand der Dinge*, 1982), that thinking in black-and-white allows you to see "the shape of things," leading fictional cinematographer Joe, played by director Samuel Fuller, to say: "life is in color, but black-and-white is more realistic." While Wenders is making a philosophical, political and aesthetic point about the "usual Hollywood colour tricks" (Nagib, 2020, 51), we might expand upon this to suggest that by appearing different from my mother's everyday vision, black-and-white allows her to see things differently. The "halving" of description makes it simpler to parse the "shape of things." The complexity of every color encounter can be deemed incorrect, manipulative or at odds with our individual phenomenological sense of reality. Making the same arguments about greyscale images, beyond levels of brightness and contrast, might prove more challenging. As Batchelor points out, our perception rapidly adjusts to monochrome images: "it takes no time and no conscious effort to adapt to the greyscale of certain films and many photographs, not to notice the absence of a vast part of our everyday visual experience. It's not just that colour is not there: its being not there is also not there: its absence is not present, not felt or experienced" (2014, 77). Batchelor is speaking of his own experience, but in my view he alludes



Fig. 1: Ungraded footage converted from the in-camera H264 codec into ProRes format for editing.



Fig. 2: Black-and-white footage from the offline rough cut (desaturated using DaVinci Resolve software).

to how the illusion of movement in film functions to make us accustomed to a recognizable sequence of images after a few seconds, regardless of the quality of the image. However we explain why it happens, film tends make us to forget its own mediation to an extent, or at least allows it to take a back seat to the events recorded within the images themselves. This is not to imply an always passive, inert, universal spectator: it is possible to take stock and remain actively aware, and individual consciousness does not disappear while experiencing a film. Yet surely one of the perennial allures of cinema, however one explains it, is this involution into the animated life generated on screen (and its disruption). Batchelor also highlights an important aspect of black-and-white images: that color does exist within monochrome, albeit rendered into a range of luminous tones—shades of grey. This becomes apparent in the mathematical data when we compare the same image as it was shot, and when it is computationally desaturated, as I will outline shortly.

By desaturating this footage within the film, I aspire to revise the documentary image. In “Kill the Documentary as We Know It” (2002), filmmaker Jill Godmilow proposes that renegotiating documentary footage adds a “second track of meaning” (2002, 9). Godmilow is reaching for an ethical, Brechtian “distance between the way things are and the way they should be” (2002, 10). She calls for “cinema as poetry, as speculative fiction, as critique” (2002, 3) rather than a presentation of documentary footage as a fixed account of the past. The second track, in my case the use of non-sync audio, voice over, and the renegotiation of footage, formulates the subject matter as a series of questions addressed to my mother (and, by extension, the spectator), seeking to highlight the incomplete or

insufficient reality on screen as well as the unreliability of memory, embodied or technical. The agencies enacted by the apparatus come into question: by renegotiating footage, I hope to destabilize programmed categories, to propose alternatives that make meaningful shifts in the materialization of images.

In the case of this particular analysis, using a simple software function to renegotiate the footage generates a useful illustration of the technical shifts between color and monochrome footage and their comparative relationship to the reality of the pro-filmic event. The software, DaVinci Resolve, subtracts color by desaturating all chroma values. A layer of computational code displays the footage in monochrome without inherently changing the original files; the desaturation can be undone at any point. At first glance it appears self-evident that I have manipulated the fidelity of the footage. However, comparing a graphical representation of the same data distances us from the photographic image of pro-filmic events, mathematically displaying precisely what has been changed. The video scopes in Figs. 3 and 4 will be a familiar sight to anyone who has color graded a film. They help a colorist identify and match levels of luminance (brightness), hue (color tint) and saturation (color intensity) between shots, as well as accentuating any imbalances that might be hard to discern by examining the image itself.

Video scopes make it easier to understand the shifts in data consequent to the software removal of chroma from the shot. The “waveform” graph on the top right maps the distribution of luminance values across the image from left to right. Values closer to white, mapped to 940, are plotted towards the top of the graph, with darker values near the bottom towards black, mapped to 16. For example, towards the right of

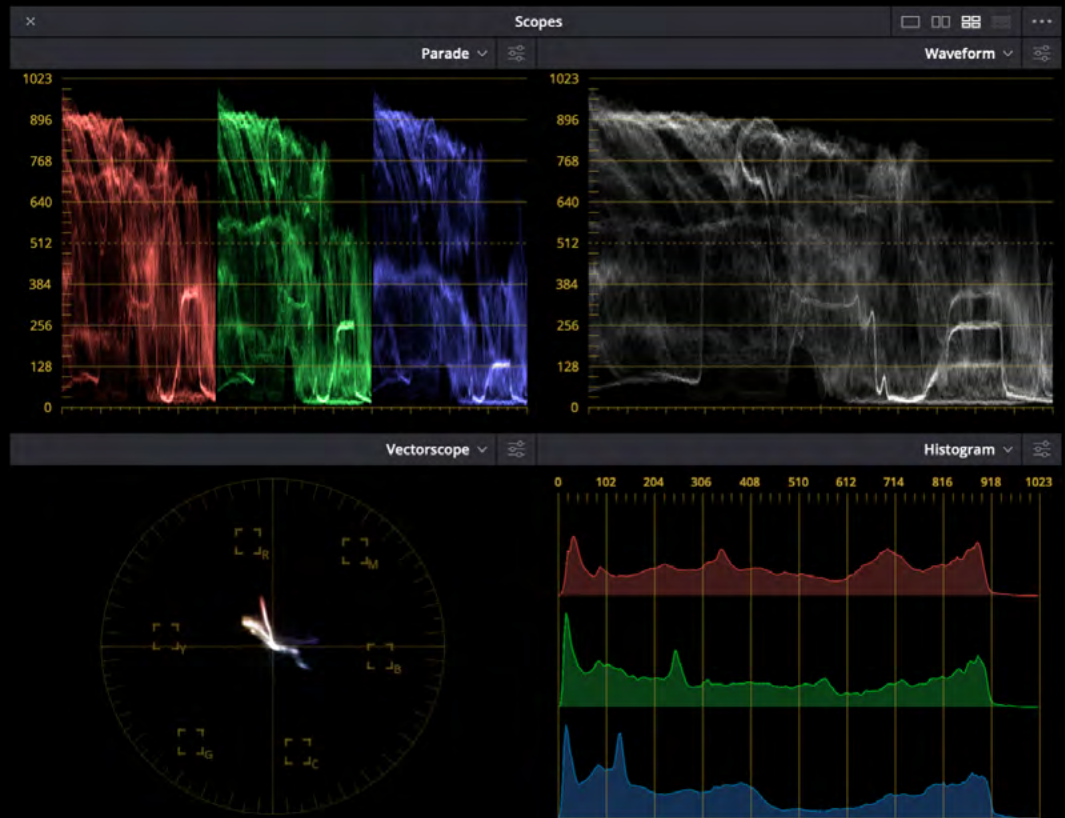


Fig. 3: Video scopes interface for the ungraded shot in Fig. 1.

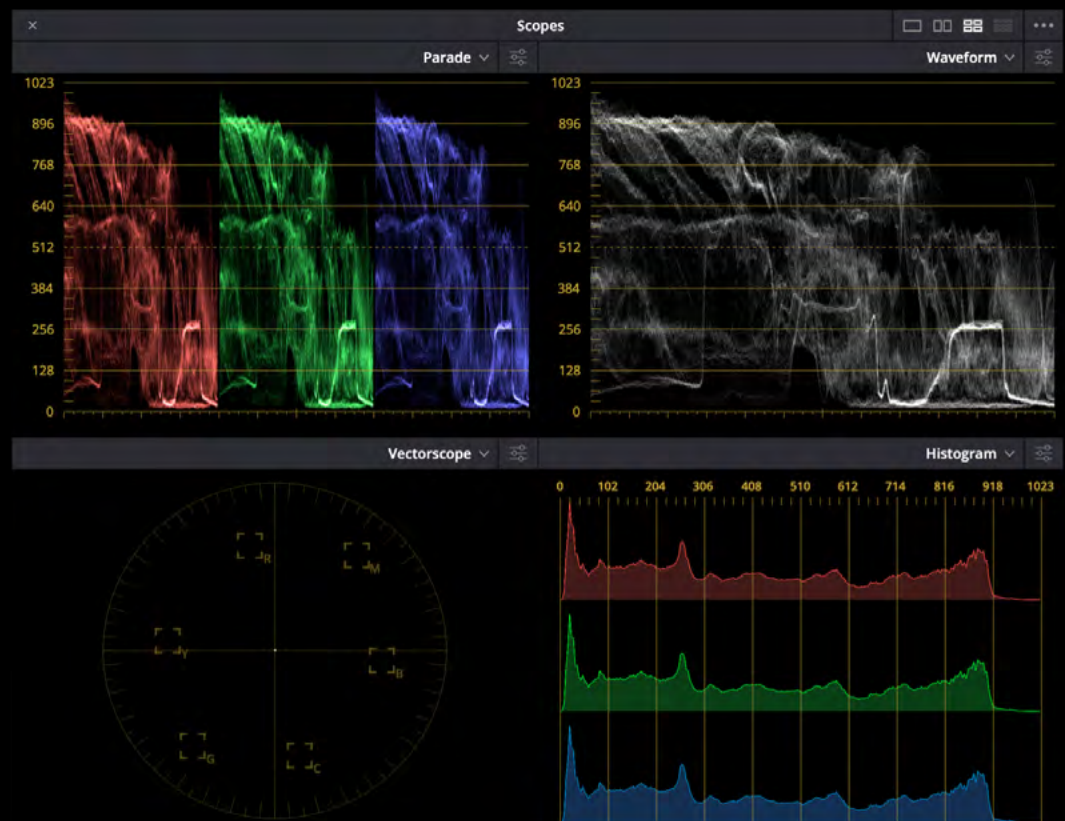


Fig. 4: Video scopes interface for the desaturated shot in Fig. 2.

the graph, there is a thick collection of points measuring around 256, and this reflects the levels of luminance on my mother's face. The "parade" graph functions identically to the waveform but is divided into a parade of the three color components used in video: red, green and blue. We can see from Fig. 3 that my mother's face reflects more red luminance than blue, with green lying somewhere in between. The parade allows a colorist to quickly determine whether one particular color or another unbalances the highlights or shadows in a shot, for instance. The "vectorscope" displays the range and distribution of hue and saturation in an image with the center representing naught and each color arranged in a radial configuration. In Fig. 3 we can see the range of values veering towards red (the cushion), blue (the blanket and t-shirt print) and a streak of values between red and yellow (my mother's skin tone). Finally, the "histogram" graphs all tonal values in the image arranged horizontally from black (16) to white (940). The second peak from the left references my mother's face, at different heights across the three color histograms according to the relevant distribution of color luminance. Fig. 4 displays data from the same shot with saturation set to zero, and no further edits made. From the waveform and histogram data, we can ascertain that no luminance data is lost, but the spread of luminance across colors contracts to similar values: all red and blue values shift to match the green from the original shot. This also produces a noticeable shift on the waveform: values are less spread out as the red and blue channel now match the green, as can be verified from the parade graphs. Equalizing all chroma values to green removes saturation to produce shades of grey. The green channel in-camera records twice as much data, thus being designated the dominant component. The vectorscope displays the starkest transformation:

all values coalesce around the center of the graph to signal the absence of saturation.

We can infer from these graphs that no luminance data is lost by desaturating footage, even if its graphical spread shifts somewhat. Outside of color, the indexical light record remains objectively the same, in a technical sense, to the original image. I certainly do not mean to equate removing color values in post-production with shooting monochrome at the point of production; they are patently distinct processes. Rather, the point is to show that there has been no subtraction of the light data recorded from the pro-filmic event; the only change is an equalization of all values to green to generate a greyscale image. However, by renegotiating color values from the original recording in this way, is the image a somehow less accurate record of the pro-filmic event? This brings into question what we might mean by color accuracy, and how we can measure it.

Color coding: Transformative standards

To industrialize color is to set about taming its essential mutability. The human visual system is an enormously complex, always changing system, and as such unique to each unique individual at any given moment, a constant becoming rather than a fixed being. The complexity of matter's dynamism enacts not only unique, ephemeral and protean entanglements of light, but also in their intra-action with unique, ephemeral and protean visual systems. Evidently, the ever-shifting complexities of the universe cannot be industrially replicated in the manufacturing of camera apparatuses. The unpredictable dynamism of color must be ordered and standardized in order to be technically re-synthesized. Digital cameras are marketed as

accurately recording light and color, even beyond what a human might perceive, that can later be “corrected” in post-production. As Sarah Street puts it: “Digital encourages a fascination with seeing better, deeper, sharper, to attain ‘perfect’ vision and a greater colour range and depth which is manipulated during post-production. The premise is that the technology is delivering a visual experience that exceeds human perception” (2012b, 379).

Ludwig Wittgenstein, in his posthumously published *Remarks on Colour* (1977), provides a fragmentary collage of unanswered questions, thoughts and ruminations on the “language-games” of color. According to Marie McGinn, Wittgenstein suggests that it is only by asking questions of our use of color systems that we can find any patterns and properties regarding the ephemeral phenomenon. Regarding the Newtonian system of organizing color relations into a circle, she says:

The question of whether this abstract system records the *correct* relations among colour concepts makes no sense; the system itself is what determines the structural relations between the elements of the system. The pattern within the system does not record relations between colours that were already there to be discovered. Rather the system itself constitutes the grammar of these colour concepts. [...] [T]hese patterns orderings and relations, are not only experienced as inevitable, but define what it is to calculate, or to use colour terms, correctly. (1991, 443–44)

We can therefore infer that the accuracy and clarity of color images marketed by digital camera manufacturers speaks only about precision within a particular color system, a programmed category of the apparatus rather than the measurement of an inherent property of the universe. The technology built-in to my digital camera aims to record accurate color,

but how can these unrepeatable phenomena, individually experienced in always dynamic situations, be industrially standardized? By reducing and ordering phenomena to a color framework that limits and fixes it in place through a subtractive process of color recording.

There are different methods used to digitally capture and process light and color values. The engineering involved in digital imaging technology rapidly becomes complicated, far beyond the limitations of this article and in excess of the information needed for our purposes. However, I hold that it is key to understand the technical, material framework that creates the conditions for color accuracy. As Jussi Parikka has it: “recognizing the way abstraction works in technical media from voltages and components to the more symbolic levels allows us to track back [...] from the world of meanings and symbols—but also a-signification—to the level of dirty matter” (2012, 97). The material basis for any digital sensor is a gridded array of photosensitive capacitors, pixels, that release electrons when struck by photons, thereby creating a small charge commensurate to the collision’s intensity. A series of transistors amplify the signal, converting the electrical current into voltage and eventually binary data (0 representing a small voltage, 1 a larger voltage) recorded onto a removable storage device. Each photodiode is then reset, ready for the next jolt of photons. This complex material and computational entanglement occurs for every frame of footage.

The majority of contemporary digital cameras also record color data from the pro-filmic event in this way. Similar to most color film processes (cf. Street 2012a), digital color photography usually operates in a subtractive manner: filtering out two thirds of the photons to produce a greyscale image range of either red, green or blue values that an

algorithm subsequently coalesces into a full color image. The EOS 7D sensor is covered by an array of micro lenses that bend light into each pixel, as well as a color filter array (CFA), also known as a Bayer filter,³ made up of repeating grids of color filters: two green; one red; one blue (Fig. 5). According to the patent application, the doubling of green filters mimics the photoreceptors in the human eye which have greater sensitivity to green light (Bayer 1976). This is why desaturating an image in post-production rearranges the blue and red channels to match the green, as the latter channel contains twice the record of contextual luminance data. Nonetheless, the subtractive element of color filters inevitably results in a sum loss of luminance data before the image is recorded, as some photons are obstructed from reaching the photosensor.

The raw data from the pro-filmic events recorded by the digital sensor form a matrix of numerical luminance values, a mosaic of discrete red, green and blue channels reduced from the full spectrum light that struck the pixels (illustrated as images in Figs. 6, 7, 8 and 9). The data is then typically interpreted by a computational algorithm that “de-mosaics” the image by interpolating the missing details: a mathematical *estimation* of absent data based on the averaging of values in surrounding pixels, amalgamating luminance levels from each channel to generate the final image output (Li et al 2008). The EOS 7D does not have the computational capacity to process and store raw image data fast enough and still shoot twenty-four frames per second. The data is therefore compressed into a smaller, manageable file standard as it is recorded, so that any color correction preset within the camera software is irreversibly baked into the final image. More expensive professional digital cine cameras, such as those produced by RED, Arri and Blackmagic, are able

to store large amounts of raw data and metadata that record camera settings within the image file, allowing filmmakers to change programmed color processes after the shoot (Misek 2010). RED offers monochrome sensors that record all luminance levels, but the sensors that record color use the same subtractive method to do so. All color technical images visible to humans, analogue or digital, are already multiply renegotiated from the pro-filmic event, subject to abstract, yet material chemical or electronic processes made inviolable through their scientific base, as Jean-Louis Baudry points out (1986, 287). In the case of color digital sensors of the type used by my camera, the technology breaks apart and reduces light values to put them back together into a system it can store and then decode into an image format. The quality of the indexical color is co-determined by the technology designed into the recording apparatus, which leaves its own material trace upon the index. The complex scientific process that has been greatly simplified here is perceived as accurately reproducing the objective real, concealing the consequential abstraction of matter that enables its functions.

The recording of skin tones on analogue film presents a clear example of the potential exclusions inherent in such techno-cultural standards. Lorna Roth’s historical analysis of inherent bias in visual technologies shows how photographic film stock devised for specific use (and users) enact prejudicial boundaries in scope and practice. The “light-skin bias embedded in colour film stock and digital camera design” (2009, 111) rendered darker skin poorly, with techniques of color balancing based on standards to “correctly” expose white flesh tones. By necessity, photographers of color designed their own technical methodology to get around the oversights and biases of

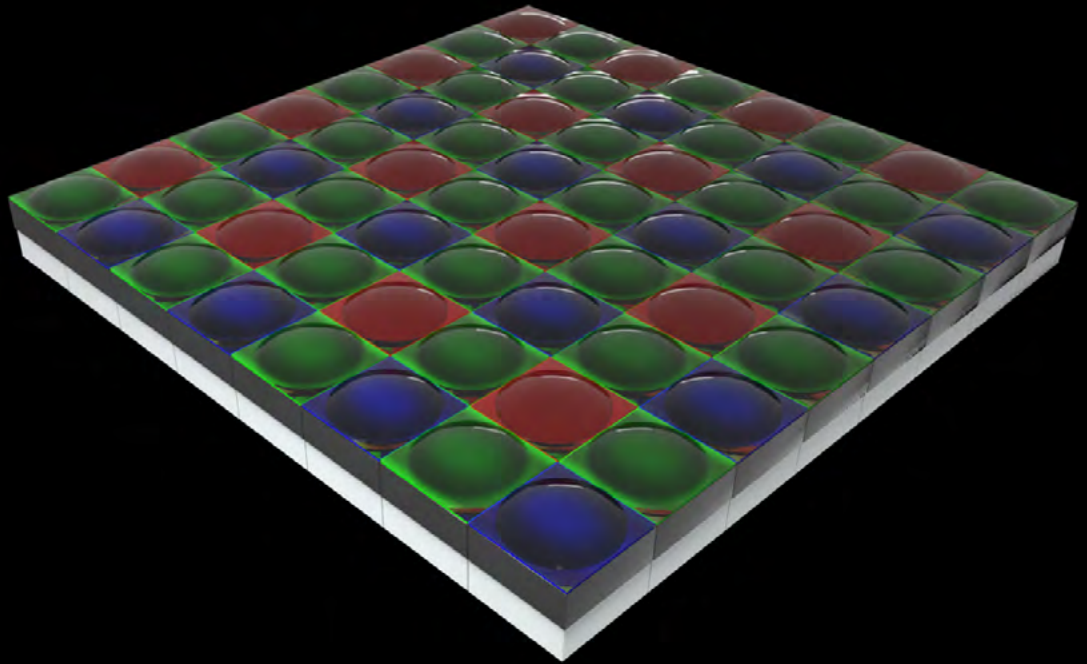


Fig. 5: Author's simplified diagram of a section of lens and Bayer color filter array atop photosensitive pixels.



Fig. 6: Red Channel.



Fig. 7: Green/luminance channel.



Fig. 8: Blue channel.



Fig. 9: Red, Green & Blue channels combined (author's illustration, color added for reference, not to scale).

film manufacturers. Euro-centric visual technologies, both analogue and digital (cf. Benjamin 2019), are often designed around standards of whiteness that excludes darker skin from visible recognition. To paraphrase Judith Butler, a normative, culturally performative technical standard produces the conditions for the very accuracy that it names, “enacting its own referent” (2011, 70).

Color values: Concluding remarks

Based on the comparison of numerical values within the pre-established standard parameters of digital cinematography, the monochrome image in question is technically no less accurate than its color counterpart: we lose none of the light record. Computational data allows us to objectively measure any changes in indexical luminance levels to arrive at this conclusion. However, shifting from color to black-and-white evidently enacts a different meaning than not doing so; the footage performs differently, and the unchanged pro-filmic events take on a different significance. Based on existing scholarship, determining this significance is just as slippery as defining color itself. Stanley Cavell, for instance, maintains that color films can generate a world of “the immediate future” (1979, 82), but paradoxically certain black-and-white films might also accomplish this by making monochrome images “function like colors” (1979, 82). Color for Cavell, even in monochrome, is thus enacted by luminous surfaces and contrasts to represent fantasy and futurity. Roland Barthes claims that black-and-white photography produces a certain truth in the purity of its recorded light, and that the “artifice” of color is akin to makeup used to paint the dead (1984, 81). Mulvey refers to an uncanny ghostliness inherent to black-and-white film images, the haunting

between “the camera’s time and its address to the future” (2006, 61). For Lara Thompson, the use of black-and-white in contemporary films “can be read as the product of monochrome photo-filmic osmosis,” a cultural memory that imagines the past in terms of its technical images as well as the cultural capital of monochrome images associated with artistic modernism (2010). For Flusser, “black/white photographs are the magic of theoretical thinking, and they transform the linearity of theoretical discourse into a surface” (1984, 30). In his account, all technical images are images of the techno-scientific concepts through which they are produced rather than of the scenes they depict. He suggests that monochrome images more closely attest to this conceptual origin by appearing noticeably different to normative human phenomenological vision. However, per Batchelor, the lack of color in monochrome sequences becomes unremarkable after a few seconds of viewing. In a sense, this lack of consensus is pure intra-action: the meaning is only enacted when it meets a particular spectator and is specific to that material encounter.

Nonetheless, my view is that the noticeable *movement* from color to black-and-white effectively reframes the meaningful agencies enacted by the camera within the pro-filmic event. By generating a discernible shift in the material surface of the image through desaturation, the same indexical image takes on a different meaning: it reveals onto-epistemological difference. By undergoing said transformation, the film interrogates the performative generation of reality on screen, aspiring to a technological honesty. To include material movements within a filmic sequence is to

interrogate the boundaries drawn in their recording, to provoke questions about the construction of the image. I seek to take responsibility for the exclusions in the boundaries of my filmic frame and duration by shifting

the material-discursivity on screen. Singularly defining what this shift means remains as indeterminate as a universal description of reality; but to interrogate what it means presupposes it is already meaningful matter.

1/ Bazin writes: “[p]our la première fois, entre l’objet initial et sa représentation, rien ne s’interpose qu’un autre objet. Pour la première fois, une image du monde extérieur se forme automatiquement sans intervention créatrice de l’homme, selon un déterminisme rigoureux” (1958, 15). Hugh Gray appears to combine these sentences, translating “selon un déterminisme rigoureux” and “objet” from the previous sentence to “the instrumentality of a non-living agent” (1967, 13). Perhaps Gray was attempting to clarify Bazin’s logic, although the original phrase cleverly leaves enough scope to question what (or who) construes the camera’s rigorous determinism, or indeed what that determinism might mean. The word “agent,” particularly in the context of agential realism, is in my view too easily misconstrued, so I opted for a more direct translation here.

2/ Barad’s theories have been applied to account for some theoretical entanglements within film and media: see Brown 2018; Kember & Zylinska 2012; Kuc 2016.

3/ The Bayer filter was named after its inventor, Bryce Bayer, an employee of Eastman Kodak.

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