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Paper Assignment

Broadening the Black and White Spectrum:

The Economic and Aesthetic Significance of Panchromatic Film Stock

Although cinematic historiography often focuses on innovations of the film image like the steps toward capturing in-camera color for film, the earlier developments executed to improve the quality and adaptability of the black and white film process include a particularly significant technological innovation: the development of a panchromatic film stock. The previous industry standard – orthochromatic film stock – had been assimilated into classical film practice despite its shortcomings in capturing a limited exposure of the color-light spectrum. However, the emergence of Eastman Kodak's new panchromatic stock in the mid 1910's opened up the possibilities of what black and white film could capture and present realistically to the audience. As a technical game-changer often overlooked due to its uniquely nuanced effect, the innovation of panchromatic stock wielded great significance in terms of both cinematic visual aesthetics like make-up and mise-en-scene and the economic machinations of the film industry's intriguing relationship between innovation and demand. By examining supporting evidence such as the first feature films shot with panchromatic stock, the technological battle between Eastman Kodak and DuPont for this innovation's control, and the radical changes to the artistic practices of black and white films, the introduction of panchromatic stock is revealed to be subtly significant as a niche tweak in film practice that played an important role in the stylistic and economic transitionary contexts of the 1910's and 20's.

Before an analysis of panchromatic stock's significance can be undertaken, however, the contextual foundation of this technological change must be established. Up to the point of this innovative shift – through the 1910's and 20's – the widely-used standard technology for black and white films of the American industry was Eastman Kodak's orthochromatic film stock. This film was primarily sensitive to blue light and insensitive to the red zone of the color light spectrum. This meant that – although these films featured no in-camera color – the real life, on-set tones on the blue/green side of the light spectrum were more easily exposed on film than the equivalent reflected light on the red side of the spectrum. As a result, blues photographed more easily and appeared bright on film, while oranges and reds remained stubbornly underexposed and much darker than natural in the final product. This warping of natural color tones was the primary, industry-wide issue with orthochromatic film. Any outdoor on-location scenes featured an overexposed sky which was often so 'blown out' as to lack any visible clouds. On the opposite end of the problem, skin tones (all of which fall into some tone of a base orange color, regardless of ethnicity) were consistently underexposed and 'muddier' than what appeared natural. Any lipstick, for example, that was red in natural light would appear black when filmed with orthochromatic stock (Lazenby).

An examination of filmmakers' efforts to combat orthochromatic film's inherent distortion issues helps paint the complex picture of why panchromatic film was technologically significant at the time of its introduction and how it addressed its predecessor's weaknesses. The issue of overexposed blue skies, though not one that filmmakers could readily solve, was not enough of a weakness to prevent filmmakers of the early 1900's from shooting primarily outside. Because all film stock up until the 1910's was of a low sensitivity, bright outdoor sunlight (often through a studio's glass roof) was the most effective option for achieving acceptable exposure

with “slow films and small apertures”, explains George Turner in his *American Cinematographer* article. Turner reinforces that although orthochromatic film’s insensitivity to yellows and reds limited what filmmakers could capture of reality, “the results obtained with primitive cameras and films were often strikingly good”. Since orthochromatic film was the industry standard by the 1910’s, American filmmakers were well-versed in working around its disadvantages, though these weaknesses still implicitly called for an imminent improvement in the technology. The popularity of shooting in more minutely controlled indoor studio environments at the time, for example, worked around orthochromatic film’s inability to render natural settings as they really appeared. In addition, the film stock’s selective sensitivity meant that filmmakers could use red light to develop negatives, as well as blue-hued carbon arc lighting when shooting (Marzola 5). However, the effect of these blue-hued lights on performers and blue-sensitive film to shoot scenes created ongoing problems in terms of visual aesthetics that would necessitate the industry-wide shift to panchromatic stock.

In order to wrangle with the division between how colors appeared naturally to the eye and how they would be distorted through exposure on orthochromatic film, cinematographers had to view costumes, performers’ faces, and sets through a blue filter in order to determine the changes necessary to reflect an “accurate” color distribution on film. Even though the films themselves were not in color, the colors captured on camera had to be carefully altered and filtered to reproduce levels of grey in the final image that appeared natural to the audience (Lazenby). The dissociation between reality and artifice when using orthochromatic film was most problematic in terms of makeup, costume, and set. In order to create a monochromatic image that appeared ‘natural’ to the audience at the time, filmmakers had to extensively alter the true colors of almost every aspect of a film’s mise-en-scene, instead of simply transferring these

visual practices over from the theatrical and vaudevillian precedents that so holistically influenced American film practice of that era. Theatrical scenic painters who moved into film set painting, for example, had to alter materials to account for the color warping of orthochromatic stock. David Sherrill Hulfish in 1911 explained that "The scenery used for setting the [film] stage differs from the dramatic stage by the absence of color… Plain black and white and neutral tints are most desirable, for color is objectionable in that it may be misleading in tone values when photographed" (Bordwell 147). In addition, this obligation to maintain an unnatural 'continuity' to appease the demands of the available film stock was reflected in industry makeup practices. "Company handouts", for example, "explained the problems of the use of reds and white with orthochromatic film stock and suggested how to avoid ending up with black eyelids and lips and halating complexions" (Bordwell 150). Therefore, even though the classical film image attempted to present a 'realistic' monochromatic image to the audience, this effort came about only through the taxing alteration of reality itself through the warping of aesthetic components' color.

The grievances of orthochromatic film stock, though not absolute enough to prevent cinematographers and designers from working sufficiently around them, still necessitated the constant technological adaptation that characterizes both American cinema through the 1920s as well as cinema technology on a whole. Thus, panchromatic film stock became available in 1913, innovated by Eastman Kodak. Chemist Hermann Vogel contributed research to this debut, as he found that "by adding dyes to film emulsions [one] could extend the spectral sensitivity" (Lazenby). The new film was, unlike the limited orthochromatic film, sensitive to the entire visible spectrum, meaning that all colors would receive equal exposure in the camera and represent a more monochromatically accurate picture of what the image set out to capture.

However, the new panchromatic film was not widely used across the industry until the mid-1920's. This technological transition was far from a simple industry-wide switch, and panchromatic film's economic significance is rooted in the context and complexity of its graduated adoption.

The subtlety of panchromatic film's economic effect stems largely from both Eastman Kodak's strategies as a somewhat monopolistic technology provider, as well as the initial disadvantages of panchromatic stock that had to be overcome. As Marzola argues in *Velvet Light Trap*, Eastman Kodak, "as one of the founding technology companies of the motion picture business, enjoyed a near monopoly over the film stock market throughout the silent period", and its relatively cheap orthochromatic film had therefore solidified itself as the industry standard, as discussed. However, both experimental opportunities and the market challenge of DuPont provided incentives for the innovation of panchromatic film, rather than solely the need to improve upon orthochromatic film's weaknesses. One aspect that encouraged Eastman Kodak's 1913 debut of its new film stock, for example, was as a strategic response to industry experimenters in color filmmaking, argues Bordwell in *The Classical Hollywood Cinema*. Charles Urban's color cinematography experiments with Kinemacolor used photography and projection through alternating red and green filters, but orthochromatic stock failed to register through the red filter; in addition, Leon Gaumont was working on his own additive color process in the 1910's (Bordwell 282). Both of these industry needs, although they were concentrated on color filmmaking, provided an economic incentive for an already-advantaged Eastman Kodak to release and market its new panchromatic stock during a visually experimental transition. This technical innovation, then, was both unique and contextually grounded in its position as an

option to uphold and improve black and white filmmaking, while also strategically catering to nascent additive color experimentation.

Panchromatic film's economic significance is also incarnated as an epitomic moment of the historical relationship between innovation and demand in the American film industry. In addition to the experimental incentives for Eastman Kodak's new technology, the entrance of DuPont, a competing business, into the film stock market positioned panchromatic stock as more than a technological novelty – it had become an arguably economical-political means of market control within a constantly shifting *and* relatively standardized industry. Panchromatic film's initial problems – to be examined in greater detail – contributed to its lackluster reception upon premiere, but as Marzola argues in his article, Eastman Kodak's pre-existing monopoly (a market control built upon its previous orthochromatic technology) meant that it did not feel the need to introduce and improve upon panchromatic film stock immediately. However, DuPont's entrance into the film stock market in the 1920's and rapid gains of market prowess presented a legitimate threat to Eastman Kodak's dominance and therefore acted as a motivating agent for the economic use of its new product. "The threat of DuPont meant that the introduction of panchromatic to regular use in Hollywood could give Kodak an advantage over its new rival, which had no panchromatic film stock to sell" (Marzola 12). It is intriguing, then, to speculate as to how much later the shift to panchromatic stock would have occurred had it relied only on the motivating agents of innovation for its own sake and catering to nascent color experimentations, and not the additional push of industry competition. The competition between DuPont and Eastman Kodak illustrates the importance of panchromatic stock as an asset during a time of technological change that was motivated by economic conditions and determined them as well. As Bordwell et al. discuss, the significance of this innovation is that "technological change can

be seen in a fuller context as contingent upon mitigating factors such as corporate infrastructure and market competition, in addition to the needs of customers and the demands of the audience" (Marzola 5).

The economic significance of panchromatic stock's graduated adoption continues with its continually self-corrective role in the film industry. As Bordwell et al. argue, panchromatic film stock initially suffered from three primary disadvantages: it was much more expensive than orthochromatic film, it was slower, and it was physically unstable, with a negative that "had to be used within weeks of its manufacture, or it would deteriorate" (Bordwell 282). These issues were coupled with the fact that, as discussed, cinematographers had developed sufficient adaptive workarounds to adjust to most of orthochromatic film's weaknesses by the early 1920's. However, the opportunity for a fully developed panchromatic film that would offer full visual sensitivity to film practice motivated continual film lab experimentation as panchromatic film was slowly adopted for photography and outdoor shoots. Through this gradual innovation, Eastman Kodak not only increased the speed and stability of their film stock in 1922, as reported by the SMPE's Committee on Progress, but also integrated its improved aesthetic allure into a marketing strategy (Bordwell 283).

Part of panchromatic film's historical importance, then, is displayed in the process of its "pitch" to the American film industry for standardized adoption. Once the film stock's speed was increased, it was finally fit to be used for entire films, and the first feature to use panchromatic stock throughout was *The Headless Horseman* (Venturini, 1922). This film and the fully-panchromatic ones that followed it, such as Henry King's *Romola* (1925), acted as agents to prove that the decade-long development of this technological innovation had finally resulted in a product that could be successfully used for full-length features to achieve the era's premiere

aesthetic imagery. In an introduction to John Grierson's 1927 *American Cinematographer* article, the editor suggested that "it was up to [the cinematographer] to foster and make known the advantages that he *knew* to exist, but which he had to *sell* to all parties interested in the making of motion pictures" (Bordwell 284). Therefore, the "field-testing" of Eastman Kodak's technological innovation reinforces an economically important trend within the American film industry, that of equipment experimentation acting beyond aesthetic aims and using its artistic potential in applicative feature films as "proof" of the merit of each technological risk. This tendency crops up repeatedly in film historiography, most notably with the attempts of Technicolor to showcase its 2-color and eventual 3-color processes through films that are meant to play up the artistic strengths of the product, but which – in doing so – act as a portfolio though which leading firms battle for economic control over the standardized tools of the industry. Just as films like *The Black Pirate* and *Flowers and Trees* stand out as landmarks for color film experimentation and market application, films like *The Headless Horseman, Romola,* and Robert Flaherty's *Moana* illustrate the similar significance of panchromatic film's response to *and* dictation of the industry's technological needs and capabilities, driven both by artistic innovation and industry profit. It is hardly surprising, then, that the "success reported by filmmakers like King with *Romola* or cinematographer Ned Van Buren on *The Headless Horseman*", as well as the heat-withstanding stability of the film proven through Flaherty's *Moana*, "would encourage the industry to proceed with the wide introduction of panchro, in spite of the attendant costs" (Bordwell 284). Thus, this graduated process of improvement, coupled with sudden pressures from competitor DuPont, opened the floodgates for industry-wide use of panchromatic film stock when Eastman Kodak finally lowered the price, effectively knocking down the last hurtle for the film industry's historic adoption of the now economically-viable product.

Panchromatic film stock's industry-wide adoption is contextually reflective of the increased level of technological standardization that had begun to characterize the American film industry in the 1920's and on, "a process that was accelerated by the founding of the Academy of Motion Picture Arts and Sciences in 1927" (Bordwell 254). It's interconnected economic and aesthetic significance is therefore also clear in its intermedium effects, in which the visual revolution brought about by the introduction of panchromatic film, granted a subtle one, worked in conjunction with simultaneous changing aspects of American classical film technology of the time, particularly make-up and lighting.

As the first fully-panchromatic feature, *The Headless Horseman* serves as an example leading the visual overhaul of mise-en-scene in response to the new film stock's technical qualities, which functioned both as anticipated opportunities for greater naturalism and efficiency in translating mise-en-scene to the final image, as well as demands to re-configure the monochromatic color theory with which to prepare and capture performers and locales. Panchromatic film's greatest strength – it's ability to evenly capture the color spectrum and correct overexposed skies and underexposed skin tones – was on peak display with this first emblematic film as well as those that followed. The new film stock was "perfect for shooting on locations, as *The Headless Horseman* was, capturing moody skies and moody eyes to equally good effect" (Hallenbeck 8). The product was similarly used for the South Seas location shooting in Flaherty's *Moana,* as he thereafter vouched for the necessity of using panchromatic film to capture "the balance of reds and blues and greens" in translation to a well-balanced monochromatic image (Marzola 11). As George Turner elaborates in his *American Cinematographer* article, panchromatic film also made possible the scenes in *Ben Hur* (1925) in which the lepers' faces healed in front of the camera. "Cinematographer Karl Struss realized that

via colored makeups and graduated color filters, he could photograph the miracle without dissolves or opticals", a principle he also used six years later for the transformation in *Dr. Jekyll and Mr. Hyde* (Turner). The aesthetic significance of what panchromatic film allowed filmmakers of the mid-1920's and on to accomplish should not be understated, as these examples illustrate the closely-tied relationship of this instance of technological innovation and the aesthetic and artistic aims which it motivated (such as exotic location shoots and narratively driven make-up tricks that occurred before the audience's own eyes).

Panchromatic film, acting as both a catalyst for aesthetic experimentation in film imagery as well as a means through which filmmakers could execute their stylistic aspirations, also exerted a great ripple effect over the make-up process. Just as the color sensitivity of film stock had now changed, so did the requirements of make-up practices; performers and cinematographers would no longer have to correct for appearance on orthochromatic film, so a trial-and-error process of discovering the 'best' techniques for panchromatic-suited makeup had to take place. As Redgrove and Foan commented in their 1930 make-up handbook, "It has been found…that with the introduction of panchromatic films and improved forms of lighting, softer tones of yellowish or brownish flesh-coloured grease-paints give much better and more natural-looking results" (Redgrove 149). A comment in 1926 *Milwaukee Sentinel* also expressed that panchromatic film, in cooperation with simultaneous improvements in lighting technology, was "making it possible for the stars to appear before the lens without reinforced layers of grease and cosmetics" (*Milwaukee Sentinel* 90). In addition to wielding influence over the make-up and cinematographic color-continuity practices of the film industry at that point in time, panchromatic stock also freed up filmmakers with the ability to film performers with little to no makeup, effectively contributing to the artistic option of understated screen makeup in great

contrast to the theatre and vaudeville-influenced traditions of heavier character makeup that had reigned up to this point.

The holistic significance of panchromatic film stock's development comes to a head when analyzed in the context of the film industry's transitional period of the 20's across multiple factor of technology, market structure, and artistic practice. In short, this technological introduction worked both in support of and as a catalyst for the visual changes in makeup, set design, and overall cinematography, as well as the increasing standardization of products that took place across the industry as discussed. The subtle but unique intertextuality of panchromatic film stock is climactically incarnated in the Mazda tests of 1928, in which it worked as an often-overlooked integral component in the 'big-name' transitions of the late 20's and early 30's, the fields of lighting and sound. These Mazda tests consisted of cinematographers exposing hundreds of hours of film on an open Warner Bros. set to test the newer panchromatic film and incandescent lighting in studio conditions. As Bordwell points out, "this massive enterprise is almost wholly forgotten," but the tests themselves contributed to the solidification of industry technical standardization under the coordination of the Academy, and they established both incandescent lighting and panchromatic film as the industry norm in the context of Hollywood's classical stylistic 1920's principles (Bordwell 295-6).

In addition to acting as one of the two principle technological foci with which these unprecedented tests standardized the industry and determined – in part – its future stylistic and technical heading, panchromatic film played a crucial, if niche, role in the conversions to incandescent lighting and sound. This technological innovation cooperated with its select contemporaries in a mutual feedback loop of industry change. As studios looked increasingly into sound cinema, the carbon arc lights that had been used with orthochromatic film gave off

too much noise, so the quieter incandescent lights arose as an option in development. However, these lights were toned on the red side of the spectrum and consequently made orthochromatic film an unfit tool with which to move forward (Marzola 12). Thus panchromatic film, which was more fit to properly expose images in conjunction with the new incandescent lights, themselves better suited to new sound cinema, emerged as a major player in this time of standardized change. The film industry's progression into updated versions of these tools was not necessarily a direct linear causation from the move to sound right to incandescent lights and subsequently to panchromatic cinema, since a myriad of financial and technical factors were contextually at play. However, there is no denying the significance of panchromatic stock as a previously neglected participant in this parallel evolution of film technology.

As a response to orthochromatic film's weaknesses and motivated by artistic experimentation as well as industrial competition, Eastman Kodak's introduction and development of a panchromatic film stock serves a unique role in film history. Analysis of evidential articles and period sources support the concept of the innovation playing an overlooked role in the parallel and cooperative evolution of film technology, as well as acting as an important influence on reinforcements *and* changes to visual practices and the film stock market of the 1910's-20's. Panchromatic film stock's economic and aesthetic significance is, as analyzed, rooted in its niche function as a cinematographic determinant and as a historiographic development that serves as an important aspect of innovation and industry feedback during one of American film history's most notable periods of relatively standardized transition.

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