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Issues of Fidelity and Authenticity in Digital Restoration of Black-and-White Films

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Fidelity and Authenticity

A generally accepted and therefore required parameter of digital restoration is to remain faithful to the original authorial concept of the cinematographic work and to respect the authenticity of the film's appearance at the time of its first release during the public première screening. This is something that archives, distributors, film festivals and, last but not least, filmmakers agree on. Even audiences want to see the film they have heard or read about and not another one. Film as such is essentially a performance, it is performative art comparable to theatre or music. To recreate a film screening, we need a screening room with a stage where a projection screen with speakers is placed, a projection booth with a projector and an audience present. In the digital age, a new technological form of hosting these shows needs to be professionally addressed. Digital projectors need data that make it possible to continue to project old archive films according to the original image and sound parameters. So it is a question of what data we provide to the digital projectors. The new digital tools have opened the way for us to recreate the desired fidelity and authenticity of the look of the original film without compromising the technical condition of the old analogue film media.

A need for new methodologies and procedures

In the Czech Republic, between 2013 and 2017, the Methodologies of Digitization of the National Film Fund using the Digitally Restored Authorizate (DRA) Methodology were developed and internationally certified [1]. The main idea of these methodologies was to maintain strict requirements for fidelity and authenticity of digital presentation of old films. A new term, "authorizate", was coined to refer to the physical product of authorizing the results of digital restoration. The authorization process is a process of approval, i.e., of an objective evaluation and definition of the fidelity and authenticity of a given digitally restored cinematographic work. The details of the DRA methodology are beyond the scope of this paper, therefore, here is just a brief description: It is an authorization that is the result of collaboration between the digital restorer and his or her expert group consisting of film image and sound experts (experienced cinematographers – ideally with the participation of the original cinematographer who shot the film – and sound engineers), film and technology historians, and other external experts invited to participate in the process. The approval authorization protocol is signed by all members of the expert group who, through their expertise, guarantee the authentic appearance of the cinematographic work in its digital form. The DRA is considered to be the digital equivalent of the original source of the film which is used to host all film performances in accordance with the intentions of the original authors.

The DRA brings great financial savings and it also saves a great deal of labour energy that is often wasted by constantly remaking new digitized versions of a single film. These extra versions occur because the digitization has been carried out inexpertly or using incorrect technological parameters. It should be stressed that the DRA protects the entire content of both the visual and audio communication and therefore does not enhance or modify this content in any way. For example, the issue of historically originated defects, such as cue marks of individual film reels or dirt in the image area, are respected in the DRA as part of the cinematographic work.

A new profession of a digital restorer

The expertise of digital restoration requires a university-educated restorer or a restorer with significant experience in the field of film camera and sound who, applying the DRA Methodology, works together with the expert group. The digital restorer supervises the work of the digital colourist who adjusts the image parameters to levels corresponding to the intention of the filmmakers who created the original film. It is also important to decide the degree of digital retouching that should be carried out (which should not be absolute) and the visual structure of the cinematographic work, i.e., its grain or colour of the base according to the reference release print. The digital restorer checks the quality of the scanning and the final production of the digital masters. The digital restorer addresses the issues of reconstruction of the cinematographic work with film historians.

Problems and threats

The issues of fidelity and authenticity are often under considerable threat of being compromised in practice. In most cases, it is a matter of not adhering to the strict parameters of the DRA. Here, I will mention two examples where the results of an otherwise very well prepared digital restoration of two black-and-white films made in the Czech Republic were altered. By black-and-white image from a colorimetric point of view, we mean a gray-scale film image. These are the Oscar-winning film *The Shop on Main Street*, directed by Ján Kadár and Elmar Klos, digitized in 2017, and *The Cremator*, directed by Juraj Herz, digitized in 2019. Both digitizations were released on the occasion of the gala screening at the Karlovy Vary International Film Festival.

We can certainly agree that black-and-white films are easier to restore, as the image degradation took place in only one black-and-white layer placed on the film base. In addition, the silver deposited in the film strip undergoes degradation more slowly than the dyes deposited in the three layers of colour materials. Black-and-white films have never been projected strictly in black and white, as the base on which the image layer is applied has its original colour. While this colour is close to neutral transparency, it has never been absolutely colourless. The film base degrades over time by darkening and strong yellowing, or rather by shifting towards a brownish-orange, sometimes greenish or purple shade. The degradation happens on a case-by-case basis, always depending on the type of the positive film stock used and the storage conditions. Work on digital restoration of the visual appearance of black-and-white film must also include a return to

the original colour appearance of the film base. Otherwise, we cannot speak of fidelity, nor authenticity, nor the DRA. The resulting DRA digitized film copy cannot be strictly black-and-white. This is how film image was produced only in the context of the black-and-white television broadcasting but we have long since abandoned this technology.

The first example

When completing the digitization of *The Shop on Main Street*, a wrong decision was made to add the unrestored orange colour of the film base to the three RGB components which, in the case of a strictly black-and-white film, should have the same values for each image stimuli. The digitization was carried out following the results of expertly created DRA samples which suggested to restore the colour of the film base to a level of ~2% of the measured orange colour tone related to the middle gray (R=128, G=128, B=128). This requirement was not met because the digital restorer was replaced by the digitization laboratory's chief technologist who did not follow the DRA methodology. He changed one of the basic parameters of the DRA, i.e., the restored colour of the film base.

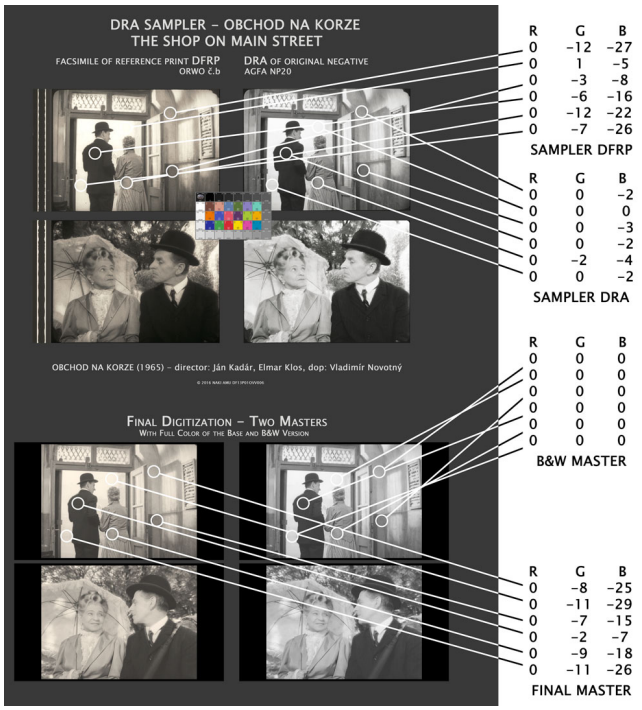

Figure 1 *DRA Sampler from The Shop on Main Street and two final digitization masters with analysis of the colour of the base.*

By incorrectly setting the colouring degree of the film base, the authenticity and fidelity to the original author's concept of the première performance of the cinematographic work was violated. At the time of its creation, the new positive material always had only slight colouring but was never strictly black-and-white. The DRA sampler recommended a level of ~2% from the degradation of the resulting color tone of the base, the digital facsimile of reference print contained ~17% and the new incorrect decision implemented the level up to ~20%.

Using the DRA sampler to compare the resulting digitized master, we can see the differences in the colour of the film base by subtracting one image field from the six selected tonal samples. The RGB values were always subtracted so that we can only see the +/- changes in RGB colour values. After measuring the existing degraded colour values, e.g., R = 159, G = 147, B = 132, we simplify it as a difference from the neutral grayscale image (R = G = B). This determines the degree of color shift of the degradation in a simplified form: R = 0, G = -12 and B = -27. A lower value of green colour represents higher magenta, a lower value of blue colour represents higher yellowing. Magenta + yellow makes orange colour. These correction values indicate only the relative changes in colour shift throughout the grayscale of the image.

Each sample was measured four times in total and the resulting readings were averaged. The colour gamut results have been simplified into a more transparent 8-bit scale by the measurement software, the original TIFF samples have a 16-bit depth. The upper part of the first figure represents the submitted DRA Sampler, where we can see, on the left-hand side, a facsimile from a selected reference print, i.e., the real degradation of the film positive print, at the date when this facsimile was made; and, on the right-hand side, a DRA restored sample from the scanned original negative. The lower part of the figure presents, on the left-hand side, the resulting colour digitized film copy compared to the strictly black-and-white version of the same image on the right-hand side.

This error resulted in complaints from the film's distributors, mainly from television stations whose technical staff noticed that the film, whose digitization was claimed to be of high quality, was not black-and-white but still degraded in a brownish tone. They therefore demanded the delivery of a new corrected and strictly black-and-white version of the film, with no visible degradation impacts. But in doing so, they demanded the creation of a new version of the film, not its digital DRA original. Neither of the cases, i.e., a film with ~10% level of the degraded tone of the film base and a zero-colour film base (0% level of the film base's tone), meets the strict restoration criteria. They are neither faithful nor authentic and are therefore not the digitally restored authorizate, the DRA. They are a new version of a cinematographic work that was not authorized by its authors.

It should also be added that at the première of the newly digitally restored film, *The Shop on Main Street* at the Karlovy Vary International Film Festival, the film was judged by the audience to be excellently restored after being screened in the Large Cinema Hall of the Thermal Hotel. The film looked black-and-white on the screen because the human eye, after a lapse of about one minute, adjusts to the white point level of the projected image and, in the brain centres of the viewers, that ~20% level of the tone of the film base is removed in about the same way as if we were watching this film projected from a current degraded analogue positive print using a film projector. This is analogous to the adaptability of the human visual system to the colour of white points in light sources of film projectors, having diverse chromaticity temperatures at different times [2].

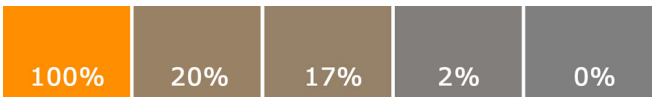

Figure 2 *Exact values of saturations colour tone of degraded base in middle grayscale.*

Second example

In 2019, a digitized film copy of *The Cremator* was produced in the same digitization studio, directly in a strictly black-and-white format. The genesis of this digitization was very similar to the first case. A DRA sampler was created, and the digital restorer also had the opportunity to consult the film's cinematographer, Mr. Stanislav Milota. The DRA sampler was authorised with a suggested colour of the film base of ~2% of the current colour tone degradation of the film base. This was also authorized by the cinematographer who shot the film himself. However, a similar error to the one made when restoring *The Shop on Main Street* occurred. The result of the digital restorer's and the expert group's work was altered by the post-production studio's digitization technologist who was concerned that the resulting masters would not be accepted by the distributors. The DRA sampler was not respected again and thus the DRA of the film was not created but a new black-and-white version with a colour base value of 0% was made. Such an approach raises doubts about the proper use of the considerable funds expended on such digitization.

Moreover, during the première screening on 29 July 2019 in the Large Cinema Hall of the Karlovy Vary International Film Festival, the black-and-white image projected in this way appeared to be defective. Many current film digital projectors are still technically unable to display a strictly black-and-white image. What sometimes appears on the screen, are even large irregular greenish or purple areas. In fact, it is enough if a single colour spot appears and the human visual system immediately fills in the complementary missing colour to the remaining neutral area. This is the well-known afterimage effect. This is still a major technical issue related to the design of light sources and recombination optical prisms in powerful digital projectors. This time, the festival audience did not rate the black-and-white result as positive but as disturbing. However, when the black-and-white image is coloured as in the DRA, the projectors do not have this problem. They try to reproduce the colour tone only in one direction. Unfortunately, the cinematographer Stanislav Milota did not live to see this sad projection, and therefore could not object to the quality of the digitization.

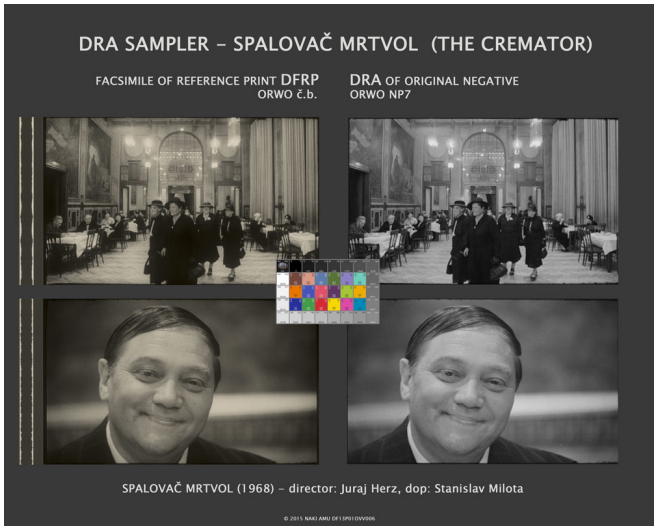

Figure 3 *DRA Sampler of The Cremator, left: Digital Facsimile of Reference Print (DFRP) and right: DRA from the original negative (53 years old).*

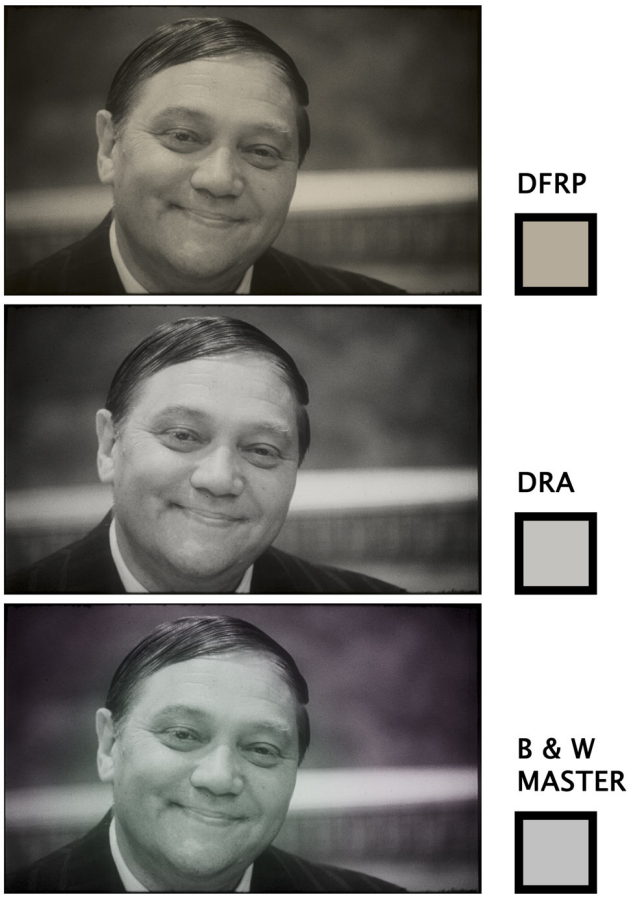

Figure 4 *The DFRP on top, the DRA in the middle and below is the completely B&W MASTER version of the film with an "amplified simulation" demonstrating what, black-and-white master looked like during its technically imperfect projection on the big screen of the Karlovy Vary IFF.*

Colour film

If we compare this situation with the digitization of colour films, we find that colour materials are much more degraded, with large differences between the degree of degradation of the poor quality dyes of the combined reference release prints and the better quality original negatives. The resulting colour DRA digitized film copies are not subject to big changes in perceived colour authenticity as is the case with black-and-white films. The colour of the degraded film base is restored automatically along with the colour of the entire image. The human brain does not have a neutral black-and-white reference available to compare and visually harmonize disturbing colour changes more accurately and quickly. Also, digital projectors do not suffer from the inability to accurately reproduce black-and-white and grey neutral tonal scales.

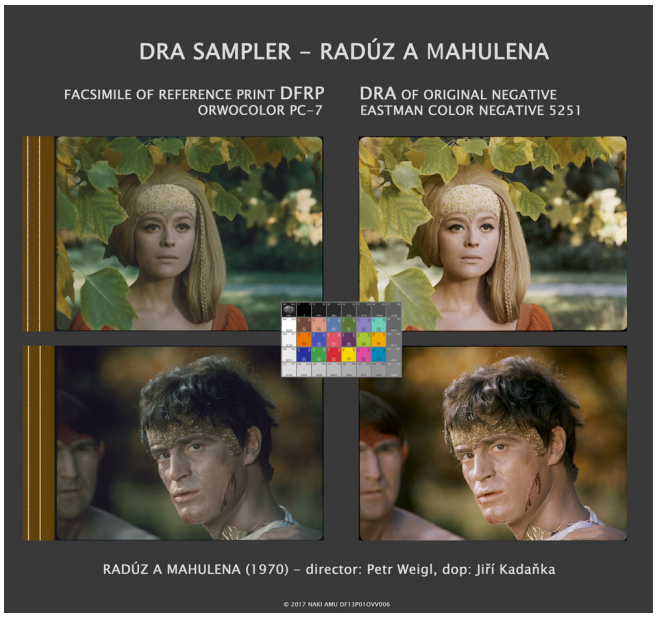

Figure 5 *DRA Sampler of Raduz and Mahulena, left: Digital Facsimile of Reference Print (DFRP) and right: DRA from the original negative (51 years old).*

Figure 6 *DRA Sampler of Silvery Wind, left: Digital Facsimile of Reference Print (DFRP) and right: the DRA from the original negative (67 years old).*

This was well known to the cinematographers who were finalizing new colour films and preparing them for their première screenings. The laboratory process of producing a single 600m colour film reel of a colour positive combined copy was often typical of a defect in that the beginning of a film reel had a slightly different colour tone than its middle or end. This was due to the difficulty to maintain standardization of the laboratory development process. This would not matter, given the human eye's ability to adapt quickly to reading and readjusting its sensitivity to slight white point colour variations, if there were no switching between subsequent film reels in the film projectors. The linking of the film reels of the première print was always strictly monitored by the cinematographers who mixed the première print from the various prints by carefully matching their film reels so that all the film reels of the film would relate to each other in terms of colour.

The human eye adapts to a white point colour shift within tolerances (~ 3,000K – 12,000K) relatively easily within tens of seconds and accepts the new value as a reference white point. Due to the relative perception of all other values related to this reference, the viewer then watches the film as correctly reproduced even if the film is projected using, for example, a very warm halogen bulb or an old carbon projector. We will not take into account the possibility that the two film projectors may have had differently set chromaticity temperatures of the light sources as we are talking about synchronized film festival projections and/or laboratory technical controls.

The difference between a black-and-white film and a colour film is therefore crucial in that the human visual system "forgives nothing" in the case of a black-and-white image due to the high sensitivity of the adaptation to grey tonality. Here, fidelity and authenticity are subjected to much stricter criteria for the final quality which is what the DRA strives for. The DRA samplers published above were created as an output of the NAKI research project No. DF13P01OVV06 carried out at the Academy of Performing Arts in Prague [3].

The colour of the film base

The actual setting of the colour of the film base should be the subject of further research. In the current practice of digital restorers, the default film base colour is set according to the measured degradation of the grey reference tone on the so-called "China Girl" or "Marcie". This is a colour test pattern that was placed by the film laboratory at the beginning of each film reel (a reel leader) of a 35mm film combined copy. The practice tells us that by simply reading the colour from this grey reference patch and by assigning ~2% of the intensity of this tone to the resulting DRA, we achieve qualified derivation of the authentic appearance of the colour of the black-and-white film base from the time of the film's première. The colour gamut set in this way most closely approximates the DRA. From these reference test patterns, the degree of darkening degradation of the reference print can also be analyzed as a source of measurable information for the analysis by the expert group restoring the image from the original negative. In the case that these patterns are not preserved in the positive prints, the degraded colour of the film base can be read between perforation, but it is already difficult to define the darkening of the whole image in this way.

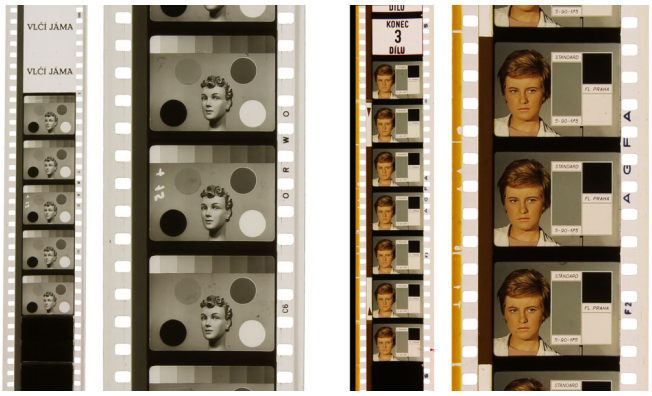

Figure 7 *DRA Reference test patterns in the black-and-white ORWO positive print of the film The Wolf Pit and the AGFACOLOR colour print of When the Cat Comes. The grey reference patches are easily measured using specialized densitometers.*

Responsible approach

Film historians, together with film archive administrators, should control and demand that the original fidelity and authenticity of a projected cinematographic work be maintained. It is often they who commission the digitization of films. Also, film distributors, who should be concerned with audience satisfaction, should include in their distribution requirements the protection of the originality of cinematographic works. Protection against unprofessional demands by some television companies needs clear methodological education and the creation of consistently set and internationally understood standards. However, the DRA methodology is still not recognised by FIAF and is not supported by film archives, leaving no effective means for the protection of authenticity. DRA as an official tool of digitization is such a defence. DRA enables the work to be screened faithfully and authentically as it was filmed, from the position of the creative (moral) right of authors, globally recognised as immutable. In films, those rights are honored by the quality of the film's performance.

The perception of film as a living art and the awareness of the fact that film is primarily a performance should lead historians, archivists and authors to work more closely together. In fact, the developed digital technology as a new tool helps them to do so. Further cooperation is needed to maintain standardization and education not only in the reproduction of black-and-white digitized film copies. Film should only be screened as a complete work of authorship. The creation and distribution of new black-and-white versions, distorted in various manner, corrupted or completely desaturated, should be neither the practice nor the standard for which the audience of such screenings pays. In essence, there is no difference between an originally black-and-white film being artificially coloured or artificially desaturated. In both cases, new versions of the films are created that their authors do not agree with. The price of a ticket to a film screening should now also include a guarantee of the DRA, as an unquestionable right of the audience and the authors of the films screened, of the completeness of the product presented.

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