METROPOLIS 2010: A New Effort to Recapture the Lost METROPOLIS

The unexpected discovery of an almost complete version of METROPOLIS in the Museo del Cine in Buenos Aires led to a new digital restoration less than ten years after the last restoration attempt. The paradoxical situation of having, for the first time, an element which contains most of the lost scenes, but of realising that their condition renders them beyond restoration, led to a project concept which put digital restoration technologies to the test. At the same time, the fully digital workflow opened up new opportunities for a collaboration of specialists with different backgrounds.

METROPOLIS (1925-27) is probably one of the most representative case studies in the field of archival film restoration. The story of the film's deliberate destruction by distributors and its own production company has become a myth and has evoked the desire of several generations of film archivists and historians to restore the lost premiere version. Each of the four restoration projects carried out between 1969 and 2010 – not to mention various archival and other versions – can be considered showcase restorations and in each case they brought both film restoration in general and the recovery of the premiere version to new levels. The first effort to restore METROPOLIS, undertaken by the Staatliches Filmarchiv der DDR between 1969 and 1972, was probably the first film restoration to assemble known versions and elements as they were available in the FIAF archives at the time. The restoration project by the Filmmuseum München between 1984 and 1988 led to the first critical edition in the field of film restorations.

In 2001, METROPOLIS was transferred to the digital domain. The Friedrich-Wilhelm-Murnau-Stiftung in Wiesbaden and the Bundesarchiv-Filmarchiv in Berlin and Koblenz carried out the first digital restoration in 2K resolution of a feature film in Germany. The film's first encounter with digital restoration technology was accompanied by another important aspect: it was also the first time in the film's restoration history that the surviving camera negative of the US version was used. This combination resulted in a considerable improvement in image quality and led to a discussion about the opportunities opened up by the advent of new technologies. This version could claim to be closer to the premiere version than ever before: on the one hand, it followed the philological approach of the Munich reconstruction and, on the other hand, it once again brought out the full quality of the photographers' work. Digital restoration algorithms allowed for the traces of time and the divergence of the different source materials used for the negative's completion to be coped with more efficiently than photochemical technologies would have.[1]

In 2008, the entirely unexpected discovery of an almost complete distribution version for the Argentinian market confronted us with a paradoxical situation: this was the only version in existence containing the scenes that had been eliminated in 1926 and 1927, but at the same time these scenes were veiled by a layer of dirt and scratches keeping us from catching sight of them. The negligent duplication of the now lost 35mm Argentinian distribution print onto a 16mm reduction negative introduced a profound difference between the original and the duplication: 1) the loss of image information caused by a duplication in sound format; 2) the lack of definition in large parts of the negative and an overall instability most probably caused by the lacking repair of the perforation of the outworn print, which, in addition to its possible shrinkage, prevented the film from remaining even during the duplication process; 3) and finally, a loss of image information caused by duplicating the print without any cleaning or wet-gate.

This time, the aim of the digital restoration technique was to extract as much information from the destroyed image as possible. The extreme, imprinted destruction rendered any of the classical physical restoration techniques, such as repair and cleaning of the source material or wet-gate scanning, useless and defined digital image restoration as the only possible way to restore this material.

As in 2001, the latest restoration was one of the most ambitious restoration projects in terms of cost, exposure, project complexity and agenda to have been carried out by the Murnau-

METROPOLIS
16mm print of the Argentinian version
(Courtesy of Uwe Dettmar / Friedrich-Wilhelm-Murnau-Stiftung, Wiesbaden)

Stiftung, this time in collaboration with the Deutsche Kinemathek in Berlin and the Museo del Cine in Buenos Aires. After news of the discovery of lost scenes was confirmed in early summer 2008, the project's conception envisaged a completion of the 2K data of the 2001 version as well as added music to be produced by ZDF/arte on the basis of the original orchestral score by Gottfried Huppertz. The new version was scheduled to be presented at the 60th edition of the Berlin International Film Festival in February 2010. Based on their rich knowledge about the specific editorial problems that originated from the extensive restoration history of the film, a team of curators was established. This team consisted of Martin Koerber, who had curated the 2001 restoration together with Enno Patalas, conductor Frank Strobel, who was also responsible for the adaptation of the music score on behalf of ZDF/arte, and myself.

Clinical Trial

The degree of destruction of the Argentinian footage described above rendered the image restoration the most challenging part of the project. Hence, the careful selection of the technical service provider was the first step in this project. Nine laboratories and post-production companies were asked to submit suggestions for the image restoration process, as well as a cost estimation and a work plan. Five of these companies were subsequently invited to submit a series of work samples showcasing each relevant step in the restoration and mastering process:

- 2K scan from the 16mm reduction negative on hard drive
- Conversion of the 2001 8-bit linear data files into 10-bit logarithmic data files on hard drive
- Digital restoration sample of the 2K scan of the 16mm dupe negative including retouching, stabilisation, grain reduction and colour correction plus insertion into the converted 2001 data on hard drive and output on 35mm b/w negative
- 35mm b/w positive from the film-out of the restoration sample on 35mm b/w negative

The extensive test requirements reflect the project's complexity: apart from the challenge of image restoration, it was crucial that the quality of the test could be successfully transferred to the analogue world. With respect to the various plans for distribution, the new restoration of METROPOLIS was to be made available as 35mm prints and DCP for cinema release, as HDCAM SR for television and DVD/Blu-ray sales and also, in part, for cinema.

For the work sample from the Argentinian element, a sequence from a scene in the ›Auftakt‹ was selected in which Georgy, disguised as Freder, is driven through the upper city of Metropolis. This sequence was especially demanding as, in addition to dirt and scratches, it is affected by bright stains, clearly caused by oil remnants on the 35mm source. As their shape and position varies from one frame to another, they appear as flickering. They repeatedly emerge to ingreasing degrees of severity throughout the entire Argentinian footage. But for this scene Thea von Harbou's screenplay describes how light from street lamps and advertisements falls through the car's windows. In the reduction negative, flickering from those intentional lighting effects overlaps with flickering from the imprinted oil and makes the two difficult to distinguish.

For an evaluation of the work samples in digital formats we collaborated with the RheinMain University of Applied Sciences in Wiesbaden. Within the framework of a research project on the subjective evaluation of restored moving images, the Faculty of Design – Computer Science – Media organised a test phase. The work samples of each category (2K raw scan, conversion, digital image restoration) were organised in a programme developed by the university for the purpose of evaluating moving images in side-by-side comparisons. A sequence was established in which each sample was compared to the other four in the form of a split-screen presentation (A with B, A with C, A with D, A with E, B with C, B with D, etc.). Each comparison pair was judged by the test person by assigning it either 0, 25, 50, 75 or 100 points. By considering the evaluation result of each comparison pair, an overall assessment of each

sample was established. The origin of the work samples was unknown to the test persons. The test persons included a number of professionals and non-professionals in the field of film restoration and film archiving.

In addition to the evaluation programme, the samples were screened in 2K resolution to be discussed by Egbert Koppe (Head of Film Restoration and Preservation at the Bundesarchiv-Filmarchiv Berlin), Martin Koerber, the technical staff of the Murnau-Stiftung and myself. The participants had been provided with a compendium of the information provided by the five companies. It contained information about the scanners and restoration software that had been used, the studios' suggestions for the digital image restoration process and the cost estimates for the various work steps.

In the discussion of the scan samples, which originated from four different scanners, the result of the evaluation programme was confirmed: the scans carried out on DFT's Spirit 4K High-Performance Film Scanner/DataCine and on the *Arriscan* provided the best results from the reduction negative, although the trend in the discussion session – held without revealing the work examples' origins – was rather pro-Arri whereas the result of the evaluation session was pro-Spirit DataCine. As the restoration samples with a conservative approach that had been done based on an *Arriscan* provided more successful results than samples based on other scanners, we considered the *Arriscan* to be the one best suited to the Argentinian negative.

While this evaluation programme was very helpful for the selection of the best scan, the selection of the best image restoration was another matter. As for the restoration work samples, the approaches of the different companies could be divided into two groups: conservative and aggressive. We received suggestions for a conservative approach from most companies. In addition, some companies provided alternative tests with a more aggressive version, which presented a more effective remedy for scratches, but also introduced heavy artefacts. In the discussion, it was pointed out that digital artefacts should not be accepted. On the other hand, a conservative approach was considered quite dissatisfying because of its poor results in comparison to the raw scan. Apparently it was necessary to define the goal of the restoration before selecting the service provider. Other evaluation criteria were the company's experience with archival film restoration and 2K workflows, the estimated cost, and the question of whether the responsibility for all work steps should be in the hand of a single service provider, especially in light of the necessity of putting the data back onto film material.

Finally, we decided on a rather unconventional route: all companies had pointed out that due to the massive damages, which are not single-frame events but rather continuous defaults throughout the length of the material, the limits of current software efficiency would be reached immediately. One company, Alpha-Omega in Munich, therefore went one step further and suggested a research project for finding software solutions for this degree of image destruction. This suggestion placed them beyond the evaluation concept. As the development of a restoration workflow was supposed to be part of the suggested research phase, Alpha-Omega could not provide a sample of a 2K image restoration that would be representative in terms of their proposal.

Instead, a restoration test was submitted which had been carried out with recent software solutions and which was comparable to the conventional approaches of the other studios. In addition to this work sample, the studio delivered a low-resolution test for which special software had been applied. The result was astonishing: almost all of the default flickering had been removed and the scratches had been repressed more effectively and free of artefacts than in any of the other samples. However, the evaluation group was doubtful whether the same result could be achieved for the whole 20 minutes of footage from the Argentinian source that were to be restored.

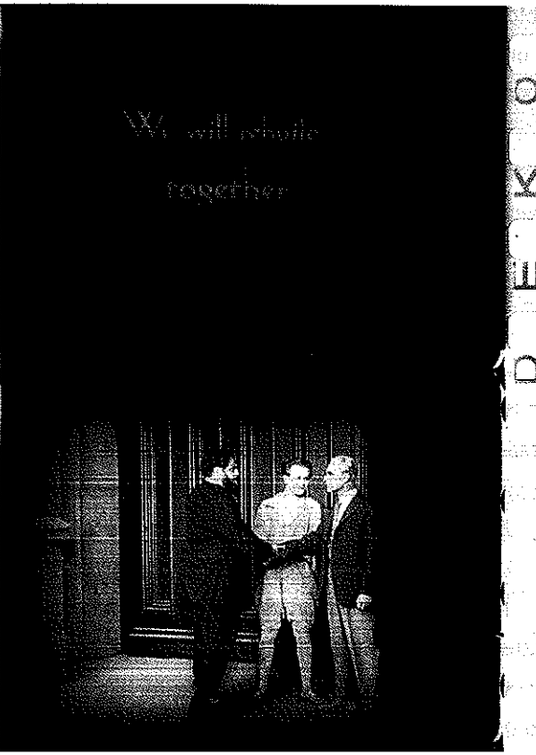
Since this restoration work sample appeared to be the only one that would lead further than the other offers, we decided to take the risk and selected Alpha-Omega for the digital image restoration. While this meant putting the film back into the hands of the people who had already successfully handled it in 2001, the *Arriscan* had clearly provided the best results from the reduction negative and it was therefore decided to separate the task of scanning from the restoration treatment.

The image restoration began in early September 2009 with the scanning of the reduction negative by Arri. For preservation purposes we decided to scan the entire 14 reels of the Argentinian 16mm dupe negative rather than only the parts that were required to complete the film. The image was scanned with an over-scan in order to receive a maximum of image content in the resulting digital files. Alpha-Omega received the files in 2K resolution and in a colour depth of 10-bit in logarithmic reproduction on hard drive. In parallel, they were backed up on LTO-5 tapes by Arri for long-term preservation. According to Alpha-Omega's work proposal, the digital image restoration started with a test phase. Within one month, a solution for the best representation of the damaged image was developed. This solution consisted of a

combination of various existing software options as well as the development of a new software approach specialised for this degree of damage due to vertical line scratches.

At the end of the research period, Martin Koerber and I surveyed the results. The degree of elimination of scratches and stains was astonishing, but the elimination had also introduced unwelcome digital artefacts. The automatic deflicker software Viva by AlgoSoft[2], by which the imprinted oil stains had been eliminated, had produced unwelcome side effects, resembling water running over the image in some scenes. For the scene showing Georgy inside the car, the deflicker tool had erroneously eliminated the intended lighting effects as this intentional flickering is similar to the moving, bright stains. Regarding the scratch elimination, the rapidly changing form of the stains was also responsible for the scratch tool's failure to recognise vertical line scratches. Apart from that, grey areas in the image further diminished the scratch tool's efficiency. The functionality of Alpha-Omega's proprietary RettMagic scratch tool differs fundamentally from other scratch tools. The latter are based on the principle of repairing damage by using pixels from intact parts of the image. As they operate on the assumption that damage is not present in the same location throughout the whole length of a shot, pixels from neighbouring frames of the damaged frame are borrowed for repair. For scratches that are not single-frame events, pixels adjacent to the scratches are cloned to replace the damaged pixels. In comparison, the functionality of RettMagic is based on a very different idea: instead of cloning the pixel, it carries the grey value of the intact pixel upon the default pixel. If the grey value of a pixel escalates between two consecutive images and returns to the value of the first image in the next frame, it may be concluded that the pixel with the divergent value is default.[3] Hence, this software ›heals images without copying external content of other images‹.[4] To what extent this software approach represents an image restoration more true to the original than conventional approaches would be worthwhile to discuss.

Nevertheless, fast movement of the image content can cause problems. Like damage, a quick change of image content causes an escalation of the grey value between two succeeding frames. Consequently, the software misreads movements as ›mistakes‹. Despite improving the software's ability to distinguish content-relevant movement from the continuous vertical line scratches, an artefact-free image ›and‹ a massive elimination of scratches could not be achieved within the given time frame of the project. While vertical lines could be removed effectively for images with comparatively little movement, the software was less effective for images with a lot of movement.



METROPOLIS
Frame enlargement, duplication of US version 1927
(Courtesy of Bundesarchiv-Filmarchiv, Berlin / Friedrich-Wilhelm-Murnau-Stiftung, Wiesbaden)

Collaboration: How to Reconstruct a *Gesamtkunstwerk*

For the recent restoration of METROPOLIS, the digital intermediate process provided the opportunity for an effective collaboration of different specialists. The Digital Intermediate (DI) process may be considered as »one of the most significant technological changes in relation to the reshaping of filmmaking and film archival practice«.[5] »In the DI process the whole film is digitised, including the scenes where no digital effects need to be added, so that the workflow, including editing, special effects, compositing, and colour grading takes place entirely in the digital environment. [...] The main reason for its success is that it satisfies the needs of all players in the film production chain, from the creators of special effects to the post-production technicians, from the people responsible for the film's colour character to

the directors of photography«.[6] The adaptation of the digital intermediate process for the restoration of METROPOLIS allowed for an efficient collaboration of different partners: service providers and their engineers, film archivists, film historians and musicians.

Digital Editing

The project started with the reconstruction of the premiere version's editing in February 2009. Access to the 16mm negative was not granted until the summer of 2009 and thus the only material on hand in early 2009 was a DVD transferred from a first print that the Museo del Cine had made from their 16mm negative. From this DVD, we could first identify all scenes, sequences or even single shots which were not present in the restored version of 2001 and therefore represented the relevant footage for the digital image restoration.

We started with the offline-editing by means of the *Avid* editing system at Omnimago's site at the Filmhaus in Wiesbaden. The Argentinian version was compared to the 2001 restoration in order to define the new parts and the places in the 2001 version where they would have to be inserted. A further source for the reconstruction of the editing was the study version of 2005 that had been created by the Universität der Künste in collaboration with Enno Patalas on the basis of the 2001 version. The editorial advantage over the 2001 version was that it took the music score by Gottfried Huppertz into greater account: Its basic idea was to start from the music as the piano score remains the only existing source to document the premiere version's editing and narrative structure. The study version contains the film's music in full length, and the missing sections are represented by grey space to »display the proliferation's disruptions and sensualise them in their temporal progress«.[7]

First of all, we created a split-screen version of the 2001 and the Argentinian versions. Based on this split-screen, the editing decision list (EDL), which consisted of an *Excel* file that had been produced for the 2001 restoration, was completed. It contained all information about the 2001 edition, including the source of every shot, scene descriptions from the screenplay and sync points from the piano score, including information for the missing parts. The EDL's shot order and numeration corresponded to the data structure of the 2001 2K files.

In the Argentinian version the editing of several scenes, which had been extremely shortened in 1926 and 1927 by Paramount and Ufa, is different from the 2001 version: in the ›Auftakt‹ this concerns the confrontation between Freder and his father eventually leading to Freder's alliance with Josaphat and Georgy, and the famous scene ›room of Hel‹; in the ›Zwischenspiel‹ differences concern Freder's fevered dream running in parallel to the dance of the false Maria; and several mass scenes in the ›Furioso‹.

One reason for this variation in editing is that the reconstruction in 2001 had to find solutions for gaps in a way that would allow to reconstruct a scene's intention and dramaturgy despite its incompleteness. Another possible reason might be changes made by the Argentinian distributor. The comparison with the 2001 version had shown that in the Argentinian version some sequences and single shots were missing. A comparison of the Argentinian version with the 1,028 sync points in the form of cue words in the piano score which documented the musical progress of the premiere version did not provide any indications of an alteration of the film's editing by the Argentinian distributor. Nevertheless, when we started to integrate the new parts into the version from 2001, we quickly realised that the reconstruction would not be as straightforward as simply filling the gaps. A closer collaboration with Frank Strobel, who was working on the reconstruction of the music score, seemed useful.

For the upcoming sessions we therefore established the following plan: Frank Strobel was provided with MPEG files of the problematic scenes. He synchronised music and image in his editing system by means of a computer sample from the piano score and sent us MPEG files of his editing suggestions in return. We compared them with our first reconstruction efforts by organising both versions in a split-screen. It turned out that if the editing of the Argentinian version was maintained, the interaction of image and music was usually most convincing. The *leitmotif*-technique, which Huppertz used to create a dramatic space in the music accompaniment by providing each character of the film with his or her own musical motif, allowed us to confirm the authenticity of the Argentinian version's editing and to reconstruct scenes in which the editing was corrupted by missing parts.[8]

Handcraft

The censorship file dated 18th November 1926 contains the entire text of the film as it appeared in the complete German version that premiered on 10th January 1927 in Berlin. Thus, it provided the corresponding German text for the Spanish intertitles and inserts of the additional scenes from the Argentinian version. The source for the original font was a 35mm fine grain master positive in the Murnau-Stiftung's archive, which was duplicated from a now lost, incomplete camera negative with German flash titles. As in the 2001 restoration, the intertitles were reconstructed by copying the font by hand. Since the original font of every

title is individual, each new title was drawn by hand to maintain an individual character. The screenplay provided the source for the line division.

Three inserts – a combination of text and image – could be completed on the basis of the Argentinian version: the note with Josaphat's address, Rotwang's letter and invitation to Fredersen, and a page from the Bible describing a scene from the Apocalypse. The partial text was reconstructed by using the German text from the censorship file and by copying the font of the Argentinian version, once more by hand. The line division of the Argentinian source had to be abandoned for both the letter and the Bible page because of varying lengths between the Spanish and the German texts. The rewriting of the texts of the intertitles and inserts was carried out by trickWilk in Berlin.

Composite

To achieve the combination of image and text for the inserts, the reconstructed German text had to be combined with the original partial image of the Argentinian source. All inserts of the film had been produced in different language versions by Ufa for the important export markets. Therefore, it may be concluded that the general artwork of the lost German inserts was identical with the existing Spanish ones. By use of a compositing tool, the company scientific!media in Berlin merged the hand-written texts with the scan of the Argentinian inserts. In addition, the shadows were reconstructed according to the Argentinian source. For the invitation letter the movement of turning over the page also had to be reconstructed.[9]

Re-Grain

Due to the specific functionality of the RettMagic software, the grain of the Argentinian footage was removed along with scratches and dirt. The large amount of dirt and scratches prevented the software from distinguishing grain from dirt or scratches.

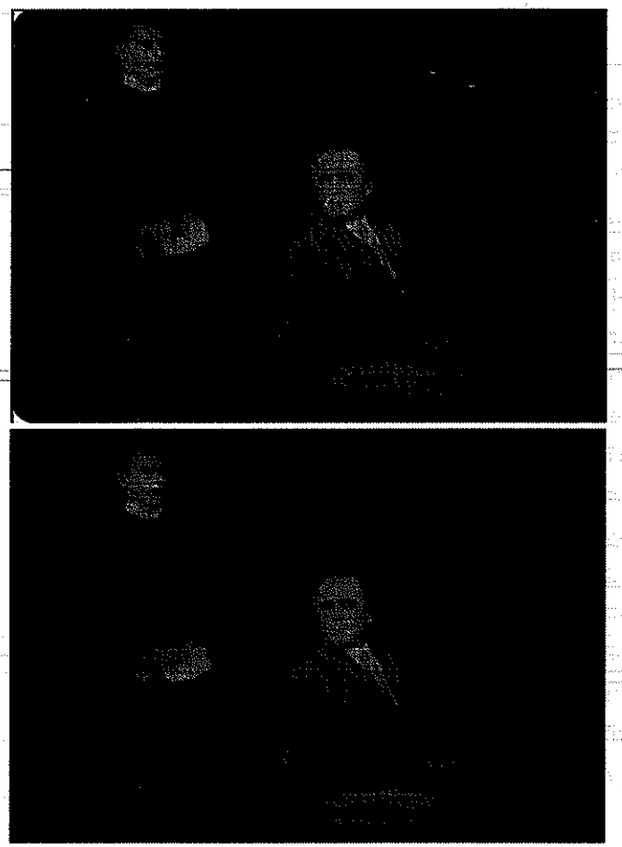
Photographic grain is a specific character of the photographic image and should, therefore, not be eliminated. In this case, the original grain structure of the Argentinian version as it was present on the 35mm nitrate print had already been manipulated by the duplication onto the reduction negative. Alpha-Omega suggested a reconstruction of the photographic grain based on the existing camera negative. The synthetic film grain was produced by scientific!media. In the matching, process values which are visually identical to the grey scale of the camera negative were defined.[10]

Loss of Image Identification

A critical approach to the presentation of the missing parts in METROPOLIS has played an essential role in the film's restoration history since the restoration by the Filmmuseum München. Unlike the previous effort by the Staatliches Filmarchiv, the Filmmuseum benefited from rediscoveries such as Gottfried Huppertz' copy of Thea von Harbou's screenplay, large parts of the sheet music as well as the censorship file. The score's sync points combined with the screenplay's scene descriptions made a theoretical reconstruction of the film's original plot and narrative structure possible for the first time. By arranging the existing footage accordingly and by replacing the missing scenes with title cards with a description of the lacking content, the Filmmuseum, for the first time, created a version as close to the premiere version as possible. Several frames of black were used to indicate cases where single shots or a larger number of frames within a shot were missing.

This concept was continued and extended for the 2010 restoration. The Argentinian version provides most of the previously lost parts and thus replaces most of the black frames as well as the scene descriptions. However, this footage is not only corrupted by heavy damage but also lacks part of the original image: a comparison of the Argentinian shots with the same shots, as they were already present in the 2001 version, shows that parts on the left and top of the image are missing in the Argentinian footage. This cropping was caused by the duplication of the silent 35mm nitrate print using a sound aperture. Therefore, the reduction negative misrepresents the image proportions of the lost Argentinian distribution print. The original proportions as defined by the photographer could be reconstructed by adjusting the Argentinian image in relation to the scale of the camera negative. The missing image information on the left and top of the frame remains black.

Both the digital image restoration as well as the reconstruction of the editing and the inserts was an ongoing process of interpretation and decision-making. The digital image restoration in terms of scratch reduction eventually was a compromise between what could be done to achieve a cleaner image and what could be achieved regarding the development of the RettMagic software during the given time frame from September to December 2009. As the software's efficiency depended on the degree of content-related movement, we had to decide if shots with less movement, and therefore a more successful remedy of scratches, should be treated differently from shots in which a large degree of movement restricted the scratch removal. For the benefit of a homogenous representation of the whole Argentinian image



METROPOLIS
Before-and-after comparison, restored version 2010
(Courtesy of Museo del Cine Pablo C. Ducrós Hicken, Buenos Aires / Friedrich-Wilhelm-Murnau-Stiftung, Wiesbaden)

we decided to adjust the scratch removal in the less problematic parts to match that of the delicate sections.

The final result of the digital image restoration can hardly be judged without comparing it to the unrestored image. Despite the massive destruction still present, there appears to be an overall agreement that METROPOLIS benefits from the added scenes in terms of the narrative structure, the dramatic effects and editing.

What is probably more interesting about this case is that the reactions towards the final version did not, as in many other cases of digital film restoration, oscillate between the two

extremes of regarding digital restoration technology as either a kind of magic or as a means to alter the very nature of film itself. Rather the interpretative interventions and manipulations which were necessary to reconstruct this version were as extreme as never before in the history of the film's restoration. It seems that the large amount of interpretation that we could introduce in this version with the aid of the DI process allowed us to more closely approach the original intentions of the creators of METROPOLIS precisely because of its degree of manipulation. It was the very possibility of digital manipulation that let emerge ethical questions concerning the grain structure and the image proportions that would probably not have been discussed otherwise.

Had we not combined the reconstruction of the editing and the music – and if, therefore, archivists and musicians had not been able to simultaneously experience image and music – the interpretation of the image would most likely have been a very different one. Without this added musical dimension we would not have revealed the dramatic relevance of the destroyed Argentinian footage and the viewers would probably not have embraced every single shot as a benefit to the film as a whole.

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[1] Koerber, Martin (2010). »Erneute Notizen zur Überlieferung des Films METROPOLIS«. In: Deutsche Kinemathek – Museum für Film und Fernsehen (ed.). *Fritz Langs METROPOLIS.* München: belleville, 58, 60.

[2] http://www.algosoft-tech.com/

[3] Naundorf, Karen & Matthias Stolz (2010). »Die Lang-Fassung«. *Zeit-Magazin* 7/2010, 31.

[4] http://www.alpha-omega.de/doku.php?id=showroom:METROPOLIS2010_2

[5] Fossati, Giovanna (2009). *From Grain to Pixel. The Archival Life of Film in Transition.* Amsterdam: Amsterdam University Press, 40.

[6] Ibid., 44-45.

[7] Bohn, Anna (2005). »Edition eines Torsos«. In: Universität der Künste, Filminstitut (ed.). *DVD als Medium kritischer Filmeditionen. Metropolis DVD-Studienfassung.* Booklet 10.

[8] Strobel, Frank (2010). »Rekonstruktion und Originalmusik von METROPOLIS«. In: Deutsche Kinemathek – Museum für Film und Fernsehen (ed.). *Fritz Langs METROPOLIS.* München: belleville, 79, 82-83.

[9] Engel, Rainer M. (2010). »METROPOLIS 27/10: Digitale Filmrestaurierung in einem offenen Workflow«. *FKT Fernseh- und Kinotechnik* 11/2010, 565-566.

[10] Ibid., 562-567.