

Policy of the Digitization of film heritage

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Background to the project

In order to give access to the film heritage outside the premises of the Swedish Film Institute, digital versions of the collections' analogue holdings must be made.

The theatres in Filmhuset will be equipped with analogue projection as long as possible, but fewer and fewer venues in Sweden and abroad will in the future be able to screen analogue films, and fewer and fewer of the venues still equipped with analogue projection will be able to handle archival prints. Furthermore, analogue prints are worn by every projection, and the possibility to replace damaged prints will continue to decrease due to the demise of film stock manufacturing and photochemical laboratory services. The analogue film heritage must therefore be digitized to be accessed at all in the future.

The purpose of the Swedish Film Institute's digitization is thus to make digital preservation-, and screening elements which as far as possible emulate the look of an analogue print as it was perceived at the time of its release.

From the digital masters created as a result of the digitization, elements for broadcasting, for DVD and blu-ray editions, and for VoD platforms are made. Access to the digital elements will more often occur on non-theatrical platforms, and other considerations may be taken in these circumstances, but the policy described in this document mainly covers digital elements for theatrical screenings.

The aim of this policy

This document has been created in order to make an efficient workflow possible, wherein policies and guidelines on how to tackle basic problems and carry out reoccurring tasks have been formulated. Specific problems and features with individual films that may arise, and which are not covered by this document, should primarily be resolved by the staff members working on the specific films in question.

This document is also based on opinions and comments gathered from international expertise in the field, and is in accordance with the *Code of Ethics* of the international film archive federation FIAF.

Please note that this document does not include selection criteria or work-flows, and does not govern in detail how the work is carried out and with what tools.

The Policy of the Digitization of film heritage was adopted by the Swedish Film Institute management in June 2014, and will be subject to constant revision. This latest revision was adopted in May 2019.

Digitization

Source elements – image

The basic principle when digitizing is to use a source element which is as close as possible to the original shooting element. This makes it possible to create a digital element which best reflects the original presentation. As a result, original negatives are almost exclusively used as a source element for digitization when they still exist, and do not have any specific problems.

In case an original negative no longer exist, a study will be made to determine which element should be used as a source for the digitization. Even though a duplicate negative is one generation further away from the original than a duplicate positive, tests indicate that it often is possible to achieve a better result when using a duplicate negative than an earlier-generation duplicate positive. In some cases when an original negative is no longer existing of a film from the nitrate era (1897-1952), an original release print is preferred to a latter-day duplication negative or other preservation elements.

The Swedish Film Institute's ambition is to scan all source elements in 4K resolution, since this procedure is estimated to capture all relevant information in the 35mm element; though only some restorations will be carried out in 4K. That most of the restorations carried out by the Swedish Film Institute will be done in 2K is because time and resources won't allow all restorations to be done in 4K, but also due to the fact that far from all source elements warrants a 4K restoration as it is many cases impossible to discern any difference in the final result.

The length of the source element shall be checked against information on original length found in the Swedish Film Institute database or information found at the website of the Media Council of Sweden (in which Statens Biografbyrå, the former censorship and classification agency, was incorporated in 2011). If there are reasons to believe that the chosen source element is incomplete, and that missing shots are to be found in a secondary element, then this secondary element shall also be digitized. All elements are over-scanned, though not to the extent that information on the edges is included, but this information is being preserved in the source elements.

All source elements are to be prepared in such a way that splices and perforation will not create any tears or damage during scanning. All source elements are to be cleaned immediately prior to scanning.

Source elements – sound

Existing digital elements are preferred, such as DTS discs or files held by rights holders and/or creators.

When no digital elements exist, the best source elements are magnetic tapes. Final mix or print masters are the primary option. In the case no mixed magnetic sound is available, the use of pre-mixes can be considered.

When no magnetic sound is available, optical sound elements will be used. Negative as well as positive elements can be used, with similar results. Due to reasons of workflow efficiency, the optical soundtrack of a viewing print is most often used.

Duplicate positives can be used as a complimentary source element, but the result is often poorer due to the lower level of contrast.

The length of the source element shall be checked against information on original length found in the Swedish Film Institute database or against information found at the website of the Media Council of Sweden (in which Statens Biografbyrå, the former censorship and classification agency, was incorporated in 2011). If there are reasons to believe that the chosen source element is incomplete, and that missing sound is to be found in a secondary element, then this secondary element shall also be scanned.

All elements with optical soundtrack used as a source element are to be cleaned immediately prior to scanning.

Consultation with creators

The Swedish Film Institute invites creators to study and contribute to the digitization process. Resources do not allow all possible creators to participate, but the ambition is to contact directors and producers still alive (and when necessary also cinematographers and sound engineers), focusing on projects where there are difficulties to determine how the original presentation looked/sounded.

Treatment – image

Aspect ratio

The guiding principle is to respect the original aspect ratio of the film. But some factors should be taken into consideration:

Frame adjustment

Some parts of the image in an analogue print are never projected, since the image is slightly cut by the aperture in the projector and by screen masking. This indicates that rounded corners at the edges of the image were probably never projected, and therefore they need not to be kept in the digital elements. A slight zoom and/or lateral or horizontal correction can thus be accepted (with the exception when downsized elements on silent films are used as the source, see below). An adjustment of the ratio shall however be constant throughout the entire film and not vary from shot to shot, unless it is necessary to do so in order to correct distortions of ratio which have occurred due to faulty duplications, or to mask black edges that originally occurred due to the use of different cameras and which were also corrected in analogue duplications.

Projection ratio differs from shooting ratio

In some cases, the aspect ratio of the source element can differ from the projection aspect ratio. For instance, films produced in the 1960s and 70s may have been shot in Academy aspect ratio (1,37:1) but are supposed to be projected in widescreen (1,66:1), even though the physical ratio of the print is Academy. Research must be conducted in each case, though technical specifications in the Swedish Film Institute database and on the website of the Media Council of Sweden can be used as an indication.

When the correct aspect ratio is difficult to determine, the digital master should be preserved in the bigger ratio, even when digital viewing elements in the smaller ratio has been created. This will facilitate the possibility of creating a digital viewing element in the bigger ratio in case new information on original projection ratio will be obtained.

Many early sound films (ca 1930-35) were shot in full frame (1,33:1), though viewing prints struck at the time were in the Movietone aspect ratio (1,19:1). Several of the viewing prints of these films in the collections have erroneously been duplicated to Academy (1,37:1), and cannot be used as reference to the aspect ratio (too much information is included on the left side of the image, and information has been lost in the upper and lower parts of the image). In most cases however, the duplicate positives in the collection, used as source elements for the digitization, are in the correct aspect ratio.

Source elements with incorrect aspect ratio

The aspect ratio has been distorted on most of the films from silent era in the collections, due to faulty duplications carried out in the 1970s, 80s and 90s. Preservation and viewing elements in Academy ratio (1,37:1) were made, even though the originals were in full frame (1,33:1). This was done by downsizing the image in duplication, resulting in a loss of information in the upper and lower parts of the image. Since information has already been lost, no further vertical adjustment shall be made when a downsized element is used as the source for digitization. A correct aspect ratio shall not be re-created by a blow-up to full frame, since information lost cannot be retrieved, and such a procedure would lead to further loss of information.

Stabilization

The ambition is to maintain a feeling of moving images, and thus complete steadiness shall be avoided. The amount of stabilization to be carried out varies, but some aspects should be taken into consideration:

Physical splices

If the source element has physical splices, the image will "jump" or "jitter" whenever a splice occurs. If the source element is a duplicate positive, or any other element never used to strike viewing prints from, these "jumps" and "jitters" should be removed as far as possible. If the source element is a spliced original or duplicate negative, analogue prints made from these elements would have included "jumps" and "jitters" at each splice

in the negative. Some instability should therefore be kept, even though the instability is probably increased in scanning and can therefore be somewhat reduced. Original splices may also have been repaired and reinforced over the years, which means that the instability after scanning is probably greater than in original prints, and should be reduced also for this reason.

Duplicated splices

If there are no physical splices in the source element, and instability occurs where splices have been duplicated from an original element, there would probably have been some instability also in analogue viewing prints in those places. Some instability should therefore be kept. However, splices in the original may have been repaired and reinforced over the years, before the source element used for scanning was struck, which means there was originally probably less instability, and should therefore be reduced.

Due to faulty duplication, some duplicate positives used as source elements for scanning may show a very high degree of instability, which shall be reduced as far as possible. When difficult to determine, comparisons can be made with an analogue viewing print.

Shrinkage

If the original element in an analogue duplication had a large degree of shrinkage, the analogue source element for digitization will display a great degree of horizontal and vertical instability. This instability should be reduced as far as possible.

In some cases (in particular with duplications of very early film), the source element is unstable to such a degree that the duplicated sprocket holes wander in and out of the picture. It is however preferable that stability after treatment is within the image with moving sprocket holes, rather than adjusting the ratio to such a degree that the sprocket holes are kept out of frame.

"Elastic" frames

Individual frames following a physical or duplicated splice may be "elastic" after scanning; meaning that the content in the image is distorted. This phenomenon is currently very time-consuming to correct, but since an equivalent phenomenon is inherent in analogue viewing prints they may be left untouched (which also facilitates the sound synch).

Grading

An analogue viewing print is used as guide for grading. One or two reels of the print is to be studied in cinema projection. An original print struck at the time of the film's release should be used as guide whenever possible, even if it is in worse physical condition than other, later prints. There are reasons to be cautious even when using an original print as guide (is the surviving print one of the first to be struck, approved by the film's creators, or is it a "mass-produced" print?), but we can at least determine that *one* print had this

look. Since it is not possible due to workflow issues to see the entire print projected in the cinema, and since the print used as guide may be unevenly graded, the ambition is to recreate the overall look and feel of the analogue print. Further aspects should also be taken into consideration:

Existing original prints cannot be used

Films shot on colour negative between 1952 and ca 1980 are subject to colour fading. Before an original colour print from this period is used as grading guide, the date of acquisition shall be checked, in order to determine how long the print has been stored in cold storage conditions. In some cases, only faded prints exist, which cannot be used as reference. If films have been subject to the colour preservation scheme initiated in 1996, newly struck prints should be possible to use as guide.

No original print exists

Hardly any original prints exist to sound films from the nitrate era (before 1953), and original prints may be missing also on films from later date. These circumstances apply almost exclusively to black-and-white films.

There are reasons to believe that laboratory technicians and preservation officers had access to original grading information when prints of these films were struck in the 1960s, 70s and 80s, in the form of original nitrate prints or punch-tapes. This may indicate that these prints could be used as guide for the digital grading, even though they were struck at a later date than the original release.

But when black-and-white prints (not originating from the time of the films' release) are soft and have grey blacks, there are reasons to believe that the low contrast is due to the fact that they were struck primarily to be used for broadcasting purposes, or struck at a laboratory whose processes were designed primarily to strike prints for broadcasting purposes. One way to determine this could be to study the soundtrack area of these prints; if the sound-track area has too low contrast, the contrast in the image is probably also too low, but if the sound-track area has high contrast, it can be assumed that the image in fact shall be low in contrast.

Silent films in colour

Hand- or stencil-coloured films from the very early years of cinema have been duplicated onto negative colour stock, which are used as source elements for the digitization. Prints struck from these duplicate colour negatives can be used as grading guide (the original nitrate prints can of course be used as guide in the very rare cases they still survive).

From the 1910s, the most common colouring methods were tinting (the black-and-white prints were dyed in colour baths) and toning (some of the silver of the emulsion was replaced by other metal salts and oxides); or a combination of the two methods. Many of these films exist on safety black-and-white negatives, which are used as source elements for the digitization (in most cases the original nitrate prints don't survive). Analogue viewing prints have been struck on colour stock from these negatives, where the colours

have been recreated in the printing process, for instance by using the so called Desmet method, which is an approximation of the original colours. The analogue colour prints are used as guide, but when original nitrate prints do survive, these can of course be used as guide. It is important however to keep in mind that the colours of the original nitrate could have been seen differently from how they appear today, due to the different light-sources in projectors and the different reflections of the screens used at the time.

Restoration

Restoration is an imprecise term, and even in the analogue era there was no clear definition of what was meant by it. By restoration the Swedish Film Institute means the creation of a digital element which projected emulates the original screening experience as far as possible.

Grain

The grain structure of the source element can be enforced in scanning, which can be corrected when necessary. Apart from this, the grain is left untouched; that is, grain is not to be removed and then reintroduced at the end of the digitization process.

Removal of defects

Scratches, dots, dirt, flicker and other defects may either be existing in the source element, or duplicated into the source element. There are reasons to believe that most of these damages have occurred over time, and did not exist in the original when release prints were struck, and should therefore be removed as far as possible.

There is really no limit to the extent of work which can be allocated to the removal of defects. For reasons of time and workflow efficiency it is not possible to fully remove all damages.

Missing frames

When individual frames in a shot are missing from the source element, these may be recreated by the making of new frames.

If individual frames are missing at a splice, it is highly probable the one frame belongs to the end of the shot preceding the splice, and one or two frames belong to the beginning of the shot coming after the splice. These frames may be recreated by the making of new frames.

If frames are missing from a section which makes it impossible to create new frames, the frames can be left missing if there is no significant sound (dialogue, music, sound effects) where the frames are missing.

If frames are missing from a section which makes it impossible to create new frames, and the section has significant sound, the missing frames are to be replaced by black frames.

If a larger amount of frames are missing from the source element, or an entire sequence (which will be discovered when the image is synched with the sound) the sequence in question shall be captured from a secondary source element, and then matched as best as possible with the rest of the film.

Original "defects" and "shortcomings"

The technologies existing at the time of a film's making mean that the end result was sometimes less satisfactory than one can assume its creators may have wanted, if other possibilities had been available at the time. This may apply to special effects, abrupt changes in grading in shots with camera movements, dirt in the camera, visible cement at splices, traces of static electricity, etc. The main principle is that no "improvements" to the original films shall be made. It is however important to determine that these "defects" stem from the original, and have not occurred in later duplications and copied into the element used as the source for digitization. If it can be established that they have occurred in later duplicating processes, they should be removed if possible.

If a film originates from a period when censorship stamps were covering some frames at the beginning of each reel, these stamps shall not be recreated if they do not exist in the source element. If the source element has censorship stamps, they do not have to be removed.

If the source element does not have change-over cues, these need not to be recreated. If the source element has change-over cues, these may be removed.

Treatment – sound

The sound restorer assigned to an individual project shall be present at the theatrical guide screening of an analogue print to get an overall feel of the film's soundscape, synch, etc.

Synching

The synching of the sound is done manually since sound and image are almost exclusively captured from different source elements. In the cases where sound and image elements include a synch beep and a synch frame 48 frames before the first image these are used as reference for the synch. Post-synchronized sound is not corrected in these cases where there are reasons to believe that original viewing prints sounded this way.

Restoration

The ambition is to achieve a digital element with a sound which emulates the sound of an analogue print screened today, not how it may have sounded at the time of the film's release. The reason is that playback equipment in theatres at the time, particularly in the early years of sound film, differs substantially from the equipment in today's cinemas.

Removal of defects

The source element for the sound is often an analogue viewing print, which often has scratches and other damages in the soundtrack area. Defects in the sound caused by such damage shall be removed as far as possible.

Missing sound

If missing sound in the source element is significant (dialogue, music, effects), the missing sound should be taken from a secondary source element, which should then be matched as best as possible with the rest of the film.

If missing sound is non-significant, existing "silence" can be stretched to maintain synchrony.

If missing sound is significant, and can't be captured from another source element, the missing parts should be left completely silent (no noise or background sound is to be added), with a gradual transition from sound to silence and vice-versa to avoid clicks in the sound-track.

Other measures

A background noise is audible in the sound-track in silent parts on older films, due to the recording and duplication technologies used at the time of production; a noise which is also present in sections with dialogue, music and effects. This noise is part of the original film and shall not be removed, though some slight reduction of the noise may be made, particularly when significant sound is hard to hear, in order to compensate for the difference in today's playback equipment.

If problems occur with very high- and very low frequency sounds in early sound films, these may be removed, since they were never transmitted when the films were originally projected due to the nature of the cinema playback equipment at the time.

Approval

The restored film is screened in its entirety in the cinema, in the presence of the grader, the sound restorer (if applicable) and the officer choosing and prepping the source elements (when needed, also the image restorer). Approval is done by a mutual decision.

If necessary, corrections are carried out. Depending on the amount of corrections, a decision is taken whether a new screening in the cinema is necessary or not, or if the corrected version can be approved without screening it.

When the screening element for cinema is approved, the remaining digital elements are being mastered and archived.

In the beginning of each digital viewing element created as a result of the Swedish Film Institute's digitization, a title with the logo and the text "This film is digitally restored by the Swedish Film Institute" shall be inserted. The title shall also include information on which source elements have been used and in what year the work was carried out.

Disagreement

If consensus among the staff members working on the film cannot be reached, decision is taken by the Head of Digital restoration and Preservation, who when necessary also consult with others. If disagreement still prevails, a decision of approval or not is taken by the Head of the Film Heritage Department.

Other

Silent films

Silent films are to be projected at a lower frame rate than sound films, usually somewhere in the range between 16 and 24 frames per second (fps). Most of today's digital projectors are equipped with 24, 25 and 30 fps. There is an international alternative frame rate standard (SMPTE 428-21:2011) which would allow digital projection also at 16, 18, 20 and 22 fps. This standard is however non-mandatory, and no manufacturer of digital projectors have yet implemented this standard, and it remains unlikely that any manufacturer will do so in the near future.

In order to screen silent films theatrically, DCPs in 30 fps are made, which includes repeated frames in an asymmetrical pattern to emulate the correct, lower frame rate.

Please note that raw scans, digital masters and other screening elements are not influenced by projection frame rate.

Digital elements to be preserved

On every film subject to digitization, a digital master and a DCP is created, as well as a browse file, which can be used internally at the Swedish Film Institute and made available for the general public in the Library of the Swedish Film Institute.

An Apple ProRes file is also made, obtainable for creators and rights holders, as this format is currently an industry standard for the exchange digital films.

Apart from the elements mentioned above, untreated raw scans of image and sound transfers are preserved in order to uphold the principle of reversibility; that is to ensure the possibility of new treatments in the future.

Documentation

The work carried out on each individual film shall be documented. Documentations shall include information on which source elements were used for image and sound. Furthermore, the measures taken regarding grading and removal of defects shall be explained. More decisive measures taken, such as the recreation of missing frames or the extension and abridgement of sound, shall be documented with exact temporal indications. By this documentation, the decisions taken in each restoration will be available for the future.