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16mm Reversal Material in the Light of a Transfer to High Definition Video

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16mm Reversal Material in the Light of a Transfer to High Definition Video

David Pfluger for Memoriav

A study founded by Memoriav
www.memoriav.ch



STARTING POINT AND AIM

Thousands of hours of 16mm reversal material lie in the archives of (Swiss) TV-stations waiting to be saved and exploited.

The archival point of view often clashes with economical interests.

Its quality in a transfer to HD video is not well researched.

This work should make it possible to reasonably judge this materials performance.



Remarks:

- Request to Memoriav from TV station about the quality of 16mm reversal material concerning transfers to SD or HD.
- Few research has been done focussing on this types of emulsions.
- Often reversal material is mentioned as "too bad" but is not properly analyzed.

PELIMINARY TECHNICAL THOUGHTS

Digitising analogue media

From EBU-TECH 3315:

" Though it is possible to calculate the resolution potential of film, comparisons of electronic and film quality are difficult to make without practical experiments. The [...] characteristics of the two media are different, and other differences in quality factors [...], which are difficult to quantify numerically, affect the final perceived quality.

Main Quality factors of a transferred image:

- * Spatial resolution
- * Resolution of grey tones and color tones
- * Colour space
- * Resolution in time
- * Grade of compression of the properties above

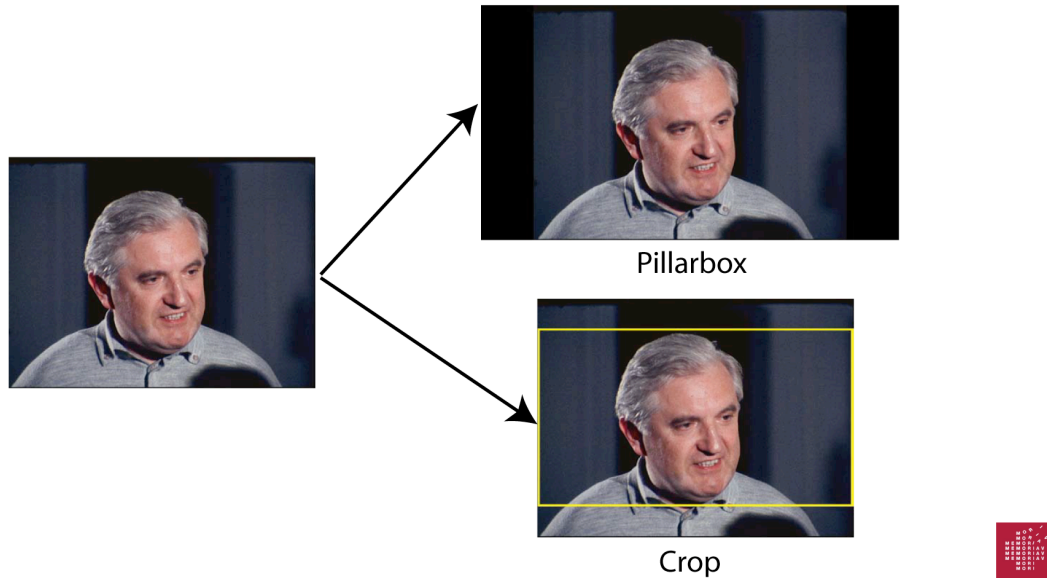


Remarks:

- Digitisation of analogue image material is not trivial

PELIMINARY TECHNICAL THOUGHTS

4:3 and 16:9 image formats



Remarks:

- Transition from 4:3 to 16:9 image format in TV is about to take place.
- Old image media conceived for 4:3 TVs has the wrong image format today.
- Often the image is used cropped instead of set-in because the channels prefer to fill the whole image area.
- This means an additional strain to the image quality of 4:3 archive material because it is reframed and zoomed into.

PELIMINARY TECHNICAL THOUGHTS

Film stock

REVERSAL

About 6 f-stops

Camera original is projection element

More grain

Sensitive

Transfer in linear bit depth

NEGATIVE

About 10 f-stops

Copy process to positive filmstock offers grading possibilities

Less grain at same emulsion speed

Less sensitive to manipulation in development

Transfer in logarithmic bit depth



Remarks:

- This test series is explicitly for reversal material.
- A good comparison with other film emulsion types like negative, or intermediates is not trivial, as the characteristics are different.
- Reversal material is inferior to almost all 16mm negative film stocks.
- Focus was set to what lies in big amounts in the archive of Swiss

TV-stations:

- Reversal
- BW
- Kodak

PELIMINARY TECHNICAL THOUGHTS

Image detail and grain structure

"Resolution is independent of film grain, but resolution is harmed by the presence of film grain because it is image noise."

(Tim Vitale, "Film Grain, Resolution and Fundamental Film Particles")

- * How is grain represented in the digital transfer in SD and HD?
- * How do compression and grain interact?
- * What are the consequences of noise reduction and other interventions on the image structure?



Remarks:

- Grain is not the visible silver crystals but clusters of them.
- Silver crystal clusters are a 3-dimensional structure

PELIMINARY TECHNICAL THOUGHTS

Image content

- * BW and colour
- * Close-ups and wide shots
- * Small structures to judge image detail
- * Well lit and contrasty material
- * Under- and overexposed material
- * Samples from different emulsion types
- * Focus charts



TEST SERIES

Output format

- * We don't intend to compare digital formats, but there is no way around them.
- * Working with uncompressed formats for the whole workflow.

1920 x 1080 pixels / 8bit linear / 4:2:2 / uncompressed



Remarks:

- There was one exception where compression was used. It is the case where the a workflow of one of the Swiss TV stations was reproduced.

TEST SERIES

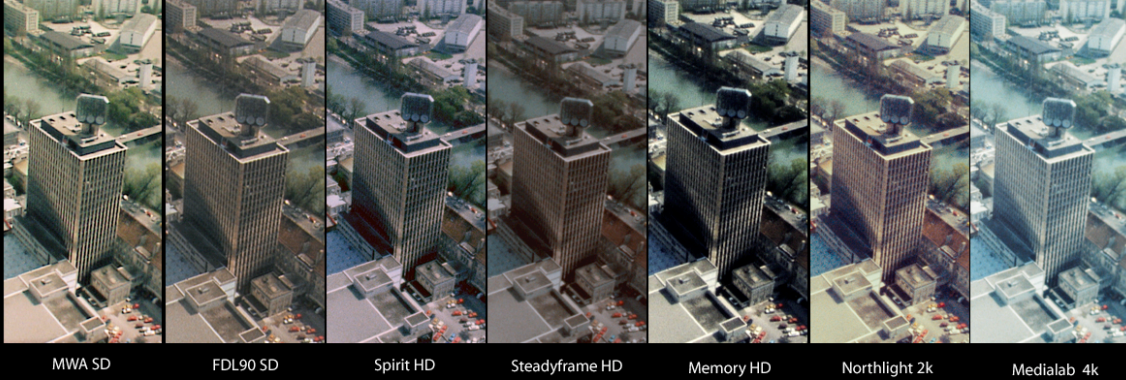
Interventions on the digital image

- * Upscale/downconversion (SD, 2k and 4k samples)
- * IMX compression (one test sample)
- * Conversion from log. to lin. bit depth (2k scan)
- * Grading (mainly black & white levels)
- * Noise reduction (seperate samples, real time and rendering)



RESULTS

Overview of all test samples



Remarks:

- Very different representations of colour in intensity and colour.
- Strong differences in grading concerning black and white levels.
- The grain is represented differently.
- The definition difference between SD and HD is there but not striking.
- Digital artifacts are there and different from system to system.
- Analogue artifacts are more eyecatching in transfers with a soft grading.

RESULTS

Spirit SD and HD transfers in comparison



Full image



Spirit SD



Spirit HD

RESULTS

Spirit SD and HD transfers in comparison



Full image



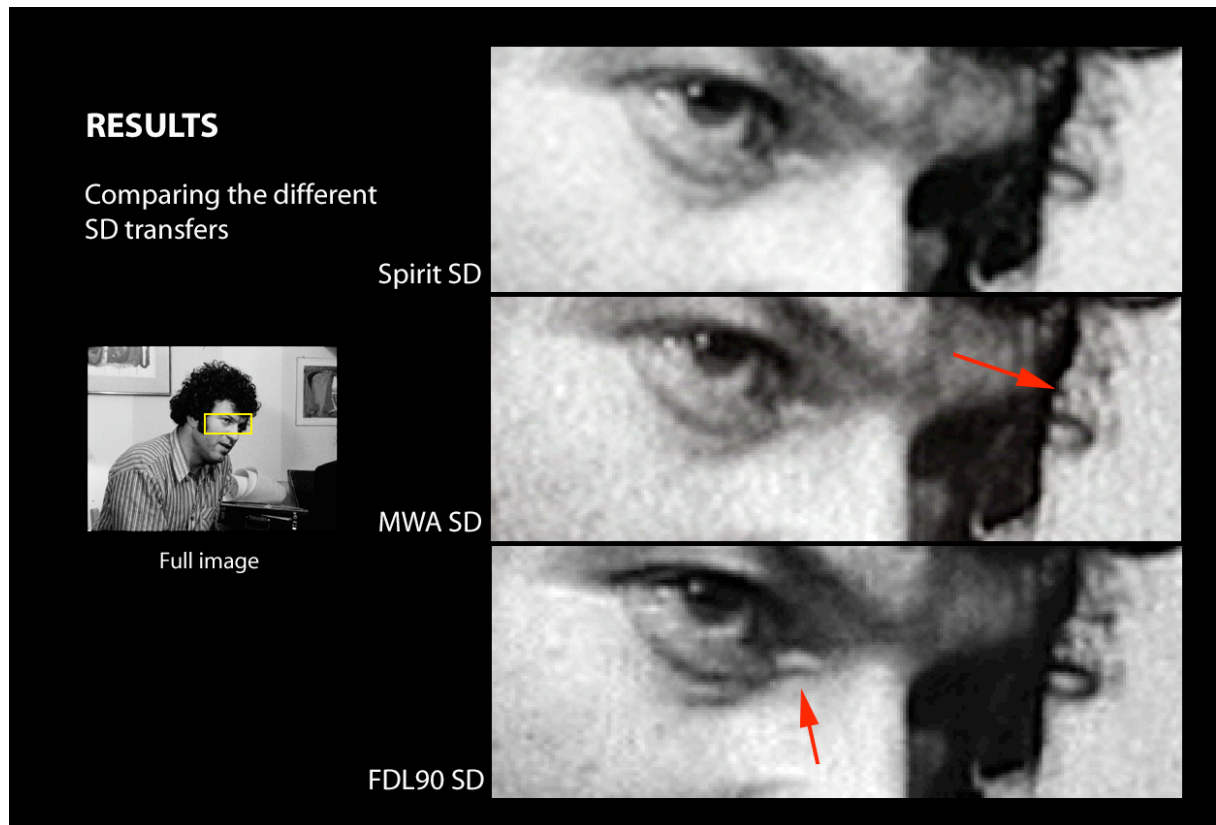
Spirit SD



Spirit HD

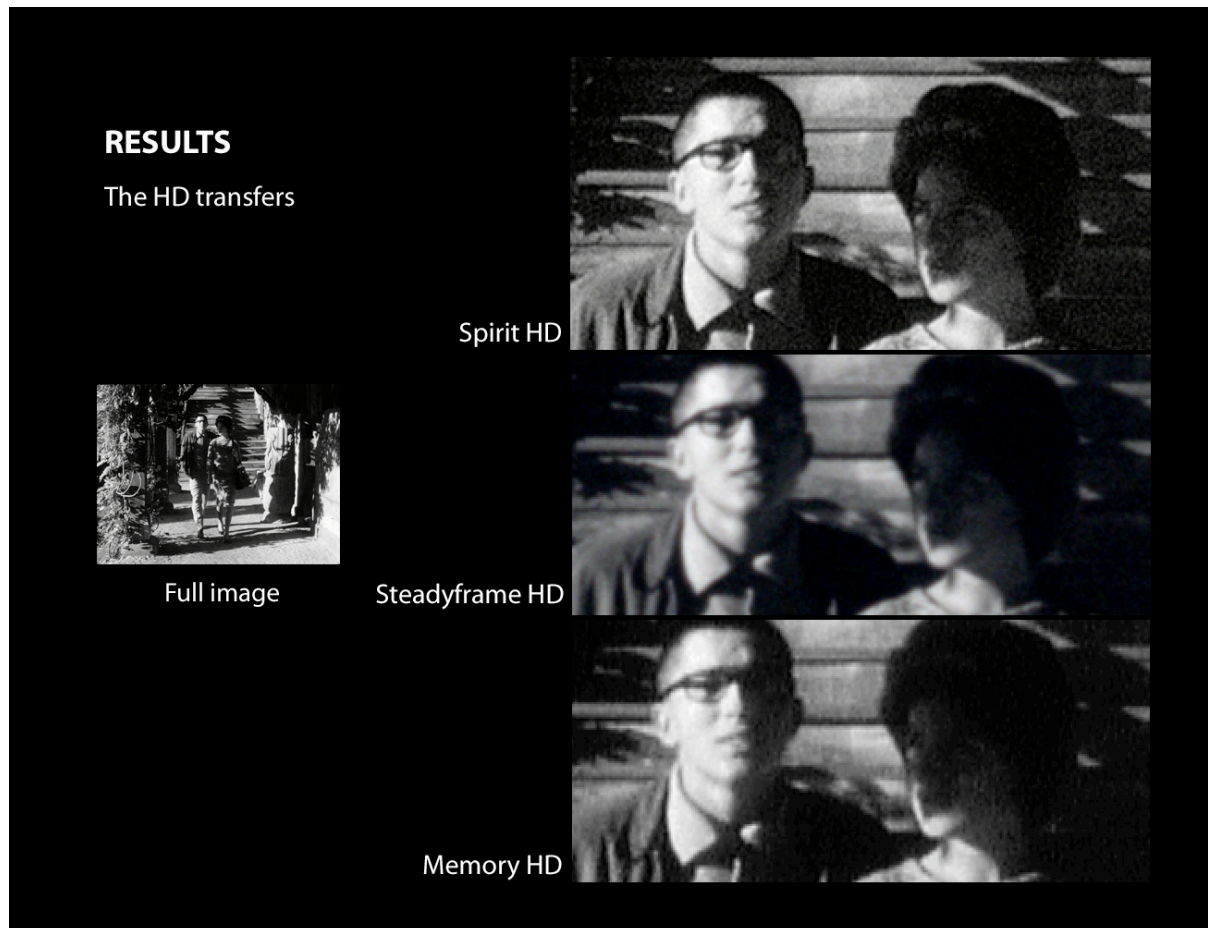
Remarks:

- The HD image is better defined, but the difference is not heavy. When zooming in on the image the differences are obvious.
- The grain is much better defined in the HD transfer and more "pointed".
- Differences are better visible with grainier material.



Remarks:

- The MWA transfer to IMX is the weakest. It shows strong video and compression artifacts. The colours are weak.
- The FDL90 to Digital Betacam image also shows strong video characteristics. It is very soft in grading. The colours are weak.
- The Spirit transfer is best by far. The least artifacts and good colours and definition.



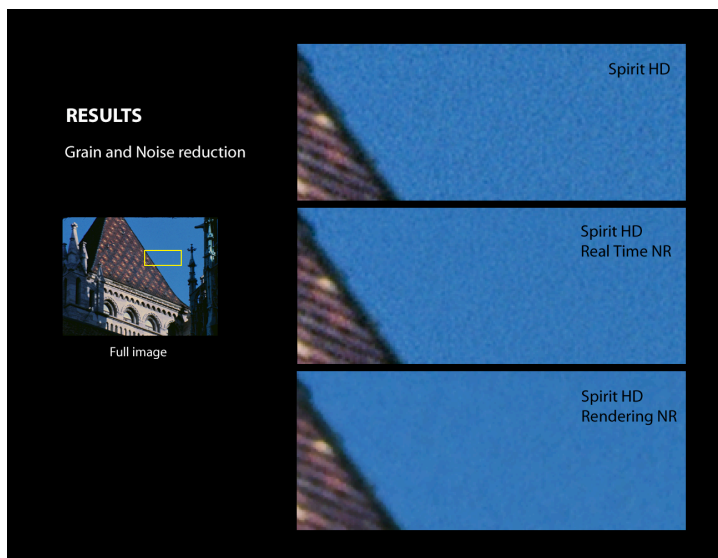
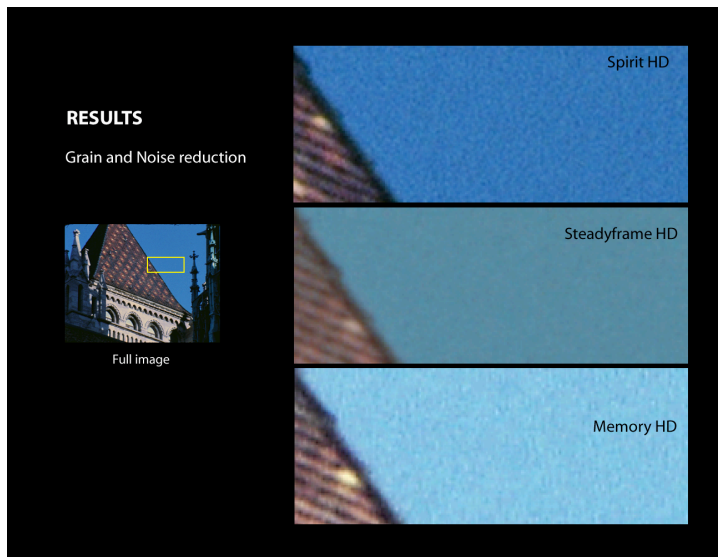
Remarks:

- The Spirit transfer is good but at a point in the dark areas the black level drops to zero. This gives bad detail in dark regions.
- The results from the Steadyframe seem to be the least sharp, but this is also due to the soft grading. It has definition in light and dark image areas. The grain doesn't come out very strongly, probably due to the fact, that the Steadyframe works with a diffuse background lighting.
- The Debie Memory delivered an image where a digital structure is best visible. Grading was quite contrasty, but better defined than in the Spirit transfer. Colors are quite weak.
- The downconversion from the Northlight transfer delivered not much improvement on the image quality.



Remarks:

- There were strong differences in the under- and overexposed samples. Mostly because of the different grading executed by the technicians.
- Testing how much could be pushed out of the envelope gave the following results:
 - The Spirit transfer was so crushed in the blacks that there was nothing to save.
 - With the compressed MWA image, the problem was that banding and digital artifacts tend to come out while grading at the edge of possibilities.
 - The Northlight sample shows how much definition is actually still there in the film original.
 - Depending on the grader and the machine, often either high lights or shadows are better defined.
 - Correcting the levels/grading improves the reception of definition with the very softly graded transfers.



Remarks:

- Grain is represented very differently
- SD definition and digital artifacts of compression interact with the grain structure as their size is similar. This is much less the case in HD transfers.
- Grain intensity is cushioned by technical characteristics of the transfer techniques (Northlight, Steadyframe)
- Noise reduction can give good results. The real time noise reduction of the Spirit machine gave better results in our case than rendering with PFClean.

CONCLUSIONS

General remarks

- * Is saving the medium characteristics as important as the image content?
- * This material was made for TV in 4:3 and SD. What are we trying to receive?

There is no single crucial parameter, but a series of decisions to be made, which should work in combination.

Even with the reduced group of 16mm reversal emulsions, we are dealing with film stock of varied characteristics.



Additional remarks:

- The grain structure is the thorn in the flesh if the images are needed for exploitation in HD TV, but from the archival point of view it is part of the medium

CONCLUSIONS

Workflow

- * Know the complete workflow and keep it as straight forward as possible.
- * Be aware of difficult steps in the chain.
- * Work closely with the technician making the transfer. He is a person of trust.
- * All transfers should be made by the same person, so you know who to refer to.
- * Decide carefully over signal processing during or after transfer.



CONCLUSIONS

Transfer machines

- * More expensive machines are generally still superior in quality.
- * Be aware of the quality of the machine of choice and properties of the transfer technique.



CONCLUSIONS

Image sharpness and grain

- * The gain in image detail is not huge in a HD transfer compared to SD.
- * Grain is represented very diverse and much better in HD. Its structure is more or less "dissolved" in an SD transfer.
- * The more intense the grain the more the image appearance gets affected by the lack of definition in SD
- * A transfer in SD combined with a compressed output format is not recommended.



CONCLUSIONS

Grading

- * A most important step and human controlled.
- * It can result in a severe loss of image data.
- * Grading must be done scene by scene.
- * Color inconsistency is a big problem which is hard to get under control as there are almost never any color references and a direct comparison between the film and its digital representation is difficult to achieve.



CONCLUSIONS

Interventions to the image structure

- * Various grain intensities must be treated differently.
Settings of degrain procedures must be tested and used accordingly.
- * There are differences in the quality of upscale algorithms.
Testing is recommended.
- * It is important to understand why an intervention is done at a certain step of the workflow.
- * Excessive interventions often give bad results and contrary to guidelines of archiving.



CONCLUSIONS

Remarks on mass processing

- * Do not give up on quality in favour of a better price.
- * The standard tape or digital format used in a company's daily workflow may not suit archival needs.



CONCLUSIONS

Key steps

- 1) Establish your aims and according guidelines.
- 2) Perform tests for every step of the workflow.
- 3) If necessary get a third parties opinion.
- 4) Establish quality control procedures and make sure the procedures are executed as discussed.



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