

Metamorfoze Version 2.0

Hans van Dormolen; Independent imaging consultant; Haarlem, The Netherlands.

Abstract

This year version 2.0 of the Metamorfoze Preservation Imaging Guidelines was published. Version 1.0 was published in 2012. The Metamorfoze guidelines are published by the KB, the National Library of the Netherlands.

Metamorfoze Version 2.0 is a technical and practical update of Version 1.0. And one of the three quality levels is completely rewritten for mass digitization with sheet-fed scanners.

With the technical update Metamorfoze Version 2.0 is in line with ISO standard 19264-1. With the practical update it is possible to use a broad range of technical targets.

The basic principle of the Metamorfoze guidelines: What you see is what you get, applies to all three quality levels of the Metamorfoze guidelines.

Metamorfoze the program

Metamorfoze is the Netherlands' national program for the preservation of paper heritage. The program started in 1997 with preservation microfilming. In 2005 the first preservation imaging projects started. The Metamorfoze program is situated in the Koninklijke Bibliotheek, the National Library of the Netherlands. The Metamorfoze program funds Dutch preservation imaging projects. Yearly around 3 million pages are digitized.

Metamorfoze the guidelines

Version 1 of the Metamorfoze Preservation Imaging Guidelines is since its publication in 2012 widely adopted by the cultural heritage community and by scanner and camera manufacturers. Version 1.0 is outdated now, mainly because of its use of formula CIE1976, and this year, 2025, replaced by version 2.0. Before version 1.0 several draft versions were published. The first draft version was published in 2007.

The Metamorfoze Preservation Imaging Guidelines provides a set of image quality standards and a clear description of its quality control and quality assurance workflow to carry out Metamorfoze preservation imaging projects.

All projects funded by Metamorfoze must comply with these guidelines. Therefore a reliable workflow of quality control and quality assurance, carried out by the client and vendor, is indispensable. The image quality of the preservation masters produced in this context and their objective measurable relationship to the originals must be such that they can be used to replace the original materials. The term 'preservation masters' refers to first-generation camera or scanner files with an embedded color space.

The basic principle and the main aim of the Metamorfoze guidelines is to ensure that all information visible in the original is also visible in the preservation master. This applies to all three levels of quality discussed in these guidelines.

This basic principle, what you see is what you get, is built on lessons learned in the microfilm projects from way back when and is achieved and assured through the objective assessment of all image quality criteria defined in these guidelines, including the associated tolerances. Proper gain modulation in the highlights is essential to ensure that all information visible in the original is also visible in the preservation master.

Gain modulation (contrast transfer) is an objectively measurable image quality criterion. The gain modulation tolerance values are the same across all three Metamorfoze quality levels in the highlights, namely 80%-110%. This tolerance value is in accordance with ISO standard 19264-1 Level A.

To ensure the correct and reliable transfer of visible information, the tolerance values must be strictly monitored for each Metamorfoze quality level, as the degrading originals are withdrawn from use after digitization. The three quality levels are: Metamorfoze Full, Metamorfoze Light and Metamorfoze Extra Light.

Version 2.0, technical update

New in version 2.0 is the use of the formulas CIE2000SL=1 and CIE2000 without luminance. The use of CIE2000 with SL=1 and CIE2000 without luminance is in accordance with ISO 19264-1:2021(E). The CIE2000SL=1 formula was developed specifically for the heritage sector. The CIE2000 formula is based on the perception (functioning and sensitivity) of the human eye. In Metamorfoze version 1.0 formula CIE1976 is used.

Also new is the use of color space sRGB IEC61966-2.1 and the use of different kind of file formats as preservation master files, like: PDF/A, PDF 1.7, TIFF with JPEG and/or LZW compression, JPEG and JP2 lossy.

CIE2000SL=1. This formula is used to calculate exposure (ΔL^*), gain modulation and color accuracy (ΔE^*).

CIE2000 without luminance. This formula is used to calculate and describe white balance tolerances. White balance (performance and tolerance) is expressed as $\Delta E(ab)^*$.

sRGB IEC61966-2.1. This color space is used as the standard color space for sheet-fed scanners projects in which the preservation masters don't have a color space embedded.

Different file formats. In version 1.0 only two file formats, TIFF 6.0 uncompressed and JP2 lossless, were accepted as

preservation masters. In version 2.0 the file formats TIFF 6.0 with LZW compression, JP2 lossy and JPEG are allowed to be used in quality levels Metamorfoze Full and Light. In quality level Extra Light it is also allowed to use PDF/A, PDF 1.7 and TIFF with jpeg compression as preservation master files.

Version 2.0, practical update

New in version 2.0 is the use of the color targets DT Next Generation Target V2 and the FADGI-ISO19264 as validation targets. Also new is the use of one single image (scan) of a frame filling UTT as validation target after a system is certified according to Metamorfoze version 2.0.

Validation targets. In version 2.0 it is allowed and recommended to use different test charts for validation and calibration. Using different test targets gives more insight in the image performance of a system (scanner / camera) then just using a calibration target. Technical targets used to calibrate and/or validate tonal and color performance should always be used with the appropriate chart-specific $L^*a^*b^*$ reference file.

UTT. Using one image instead of four different images (version 1.0) to check the image performance with, in a daily quality control and quality assurance (QC & QA) work flow, is saving time. With a frame filling UTT all the image specifications of version 2.0 can be analyzed, except for color accuracy. Instead of the color accuracy the color stability performance can be checked and monitored over time.

Version 2.0, recommendations

For some criteria, the image quality may be affected by the quality of illumination (illumination non-uniformity). To minimize this effect, illumination should be optimized. Elements that may affect illumination quality are: the distance of the light source from the original, the angle of the light source relative to the optical axis, the height of the light source relative to the original, ambient reflection from the ceiling and/or walls, and shielding of the light source and lens.

According to ISO 19264-1 and Metamorfoze version 2.0 all image criteria affected by the quality of the illumination should be assessed primarily in the center of the image plane. These image criteria are:

- White balance in the neutrals, $\Delta E(ab)^*$
- Exposure, ΔL^*
- Tonal curve, OECF
- Gain modulation, in the highlights and over the entire tonal curve
- Color accuracy, ΔE^*

Recommended in version 2.0 is that these criteria should be analyzed over the entire image plane, especially for digitizing works of art and photo's according to Metamorfoze Full.

Metamorfoze Full

This is the highest quality level for digitization. It is intended for the digitization of originals that are considered works of art, such as Vincent van Gogh's letters, illuminated manuscripts, maps, photographs, paintings and drawings. For Metamorfoze Full, the gain modulation tolerance is very tightly

defined over the entire greyscale, as is color accuracy. In order to achieve the required level of color accuracy, it is important that the tonal performance (white balance, exposure, gain modulation and noise) meets the guidelines set for this quality level down to deep blacks, L^*5 .

Metamorfoze Light

This second quality level of the Metamorfoze guidelines is intended for the digitization of books, newspapers, magazines, manuscripts and technical drawings. These originals are characterized by limited blackening, with maximum blackening generally not exceeding a reflectance density of approximately 1.20 or 1.30. For this quality level, tonal reproduction (white balance, exposure and gain modulation) and noise are therefore assessed up to a level of blackening slightly above the expected blackening in the originals. Tonal reproduction and noise are assessed up to a density of approximately 1.50, which corresponds to an L^* value around 20.

Originals with slightly deeper blackening and those where there is some doubt about the degree of blackening should be digitized in accordance with the Metamorfoze Full quality level.

Metamorfoze Full / Metamorfoze Light

File format	TIFF, 6.0 uncompressed, LZW, JPEG compression. JP2 (JPEG 2000 Part 1), lossless and lossy. JPEG.
Color space	eciRGBv2, Adobe RGB (1998)
Bit depth	16 (8) / 8
Maximum L^* value for assessing the neutrals	$L^* 5 / L^* 20$
White balance, $\Delta E(ab)^*$	$\Delta E(ab)^* \leq 3$
Exposure tolerances (Tone reproduction)	$\Delta L^* \leq 2$
Gain modulation, $L^* 95 - L^* 85$	80%-110%
Gain modulation, $L^* 90 - L^* 80$, $L^* 85 - L^* 75$, etc.	60%-140%
Noise	$\leq 1,6 L^*$ values
Illumination $\leq$ DIN A3 (Illumination non-uniformity)	$\leq \Delta L^* 3$
Illumination $\leq$ DIN A2 (Illumination non-uniformity)	$\leq \Delta L^* 4$
Illumination $\leq$ DIN A1 (Illumination non-uniformity)	$\leq \Delta L^* 5$
Illumination $\leq$ DIN A0 (Illumination non-uniformity)	$\leq \Delta L^* 6$
Color accuracy (Colour reproduction)	Mean $\Delta E^* \leq 3$ / Mean $\Delta E^* \leq 4$ Max $\Delta E^* \leq 7$ / Max $\Delta E^* \leq 14$
Required sampling rate	Min 300 ppi $\geq$ DIN A5 Max 600 ppi $<$ DIN A5

Difference between obtained and claimed sampling rate	$\leq 2\%$
Sampling Efficiency	$\geq 85\%$
MTF50	$\geq 45\%$ of the minimum required lp/mm at MTF10
Max modulation	≤ 1.05
Color misregistration	≤ 0.35 pixels / ≤ 0.50 pixels
Geometric distortion	$\leq 2\%$
Artefacts	Not accepted

Metamorfoze Full and ISO 19264-1

The Metamorfoze Full quality level is largely aligned with the informative criteria and tolerance values cited in Annex B in ISO 19264-1 (E) 2021 Level A. The differences between Metamorfoze Full and ISO 19264-1 (E) 2021 are listed below.

Dynamic range. ISO 19264-1 (E) 2021 Level A requires the dynamic range to have a density of 2.3. This corresponds to an L^* value of 3.8. Metamorfoze Full requires image quality to be assessed up to an L^* value of 5. This corresponds to a density of 2.23.

Color accuracy. ISO 19264-1 (E) 2021 Level A requires a color accuracy between mean $\Delta E^* \leq 4$ and max. $\Delta E^* \leq 10$. Metamorfoze Full requires a color accuracy between mean $\Delta E^* \leq 3$ and max. $\Delta E^* \leq 7$.

Illumination. ISO 19264-1 (E) 2021 Level A provides the following requirement for the luminance of A0 size images: $\Delta L^* \leq 5$. For Metamorfoze Full, this is $\Delta L^* \leq 6$.

Color misregistration. ISO 19264-1 (E) 2021 Level A requires a value of ≤ 0.4 pixel. For Metamorfoze Full a value of ≤ 0.35 pixel is required.

Distortion. ISO 19264-1 (E) 2021 Level A requires distortion to be $\leq 1.5\%$. For Metamorfoze Full, this is $\leq 2\%$.

MT50 performance. ISO 19264-1 (E) 2021 Level A requires an MTF50 performance of $\geq 50\%$ of the minimum required number of line pairs at MTF10. For Metamorfoze Full, the tolerance level for MTF50 is $\geq 45\%$.

Metamorfoze Extra Light

This third quality level is completely rebuild and is intended for the digitization of text documents up to A3 size using sheet-fed scanners. The text documents are regarded solely as information carriers. Only the preservation of textual information is guaranteed at this quality level. Textual information includes all printed letters, handwritten text, signatures, pencil notes, stamps, logos and shading.

The gain modulation tolerance in the highlights (between $L^* 95$ and $L^* 85$) is 80%-110%, the same as it is for Metamorfoze Full and Metamorfoze Light.

Maximum blackening in these originals generally does not exceed a reflectance density of approximately 1.20. A reflectance density of 1.20 corresponds to an L^* value of $L^* 30$. Tonal reproduction (white balance, exposure and gain modulation) and noise are therefore assessed up to $L^* 30$. Although Metamorfoze Extra Light has no standard for the level of color accuracy required, the primary colors in the digital file must match the original. This means that reds, greens and blues in the original should also be reds, greens and blues in the digital file. The degree of color accuracy does not have to be specified using technical test charts and color accuracy formulas, however.

Metamorfoze Extra Light

File format	TIFF, 6.0 uncompressed, LZW, JPEG compression. JP2 (JPEG 2000 Part 1), lossless and lossy. JPEG. PDF/A, PDF 1.7.
Color space	eciRGBv2, Adobe RGB (1998), sRGB IEC61966-2.1
Bit depth	8
Maximum L^* value for assessing the neutrals	$L^* 30$
White balance, $\Delta E(ab)^*$	$\Delta E(ab)^* \leq 5$
Exposure tolerances (Tone reproduction)	$\Delta L^* \leq 4$
Gain modulation, $L^* 95 - L^* 85$	80%-110%
Gain modulation, $L^* 90 - L^* 80$, $L^* 85 - L^* 75$, etc.	60%-140%
Noise	$\leq 2 L^*$ values
Illumination (Illumination non-uniformity)	$\leq \Delta L^* 5$
Required sampling rate	300 ppi
Difference between obtained and claimed sampling rate	$\leq 2\%$
Sampling Efficiency	$\geq 85\%$
MTF50	$\geq 45\%$ of the minimum required lp/mm at MTF10
Max modulation	≤ 1.05
Color misregistration	≤ 0.50 pixels
Geometric distortion	$\leq 4\%$
Artefacts	Textual information must remain readable and usable. Artefacts should be avoided as much as possible.

Metamorfoze and ISO 19264-1

In 2011 the ISO joint working group TC42 JWG26 was launched and initiated by Dietmar Wueller from the company Image Engineering. The intention of this joint working group was to start a research to produce and construct an ISO imaging standard based on the Metamorfoze guidelines and the FADGI guidelines.

In 2017 technical specification ISO/TS 19264-1 was published. This was the first publication after the Metamorfoze guidelines in which the gain modulation and its tolerances were adopted. New developments in this technical specification and discussed in the joint working group, like the use of CIE2000 without luminance and CIE2000SL=1, made it necessary to start with writing Metamorfoze version 2.0. A small prepublication of Metamorfoze version 2.0 was launched in 2019. ISO 19264-1 was published a few years later in 2021. This year, six years after the prepublication, Metamorfoze version 2.0 is published. In these six years quality level Metamorfoze Extra Light was totally rebuild and thorough tested for mass digitization with sheetfed scanners.

Metamorfoze, FADGI and ISO 19264-1

The Metamorfoze and FADGI guidelines and ISO standard 19264-1 are all three written to support cultural heritage imaging by providing a clear description, with aims and tolerances, for analyzing and judging image quality of imaging systems and images.

In ISO 19264-1, in Annex B, informative aims and tolerances are giving in three different quality levels, level A, B and C. In which level A is the most demanding level.

In the FADGI guidelines a star rating principle is used to describe image quality for the digitization of various types of originals, like rare & special materials, general collections, modern textual records and so on. It is a one to four star rating describing in which the 4-star rating is the most demanding.

In the Metamorfoze guidelines the demanded image quality is not described with image quality levels or with a star rating principle. But the demanded image quality is precisely specified based on the types of originals (originals that can be seen as works of art, works of art, photo's / books, newspapers, letters etc. / textual information only) and their deepest black (L*5, L*20 and L*30).

The biggest difference between the Metamorfoze and FADGI guidelines is the use of the gain modulation. A gain modulation of 78% in the high lights is not accepted in all three quality levels of Metamorfoze and is also not accepted in level A of ISO 19264-1. In the third edition of the FADGI guidelines of May 2023 the gain modulation is adopted for research and information purposes only.

Metamorfoze and sheetfed scanners

The need for reliable scanning with sheetfed according to the basic principle of the Metamorfoze guidelines started in 2018 with a mass digitization project of Waterlands Archief. In this project archival material (construction and environmental permits size A3) from five different municipal organizations was, and still is, digitized for replacement. That means that after scanning the originals will be destroyed and that the preservation masters will be the new originals. This makes

good and reliable scanning according to guidelines with a strict quality control and quality assurance work flow very important.

Scanning for replacement is a totally different approach than preservation imaging, in which the originals are withdrawn from use and stored safely after scanning to protect and preserve them. Also other governmental organizations are scanning for replacement with sheetfed scanners. For Waterlands Archief and other governmental organizations in the Netherlands I wrote project specific guidelines build on the Metamorfoze guidelines and over the years these project specific guidelines grew into (became) quality level Metamorfoze Extra Light.

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References

- [1] Metamorfoze Preservation Imaging Guidelines, Image Quality, version 1.0, January 2012.
- [2] Metamorfoze Preservation Imaging Guidelines, Image Quality, version 2.0, November 2024.
- [3] ISO 19264-1:2021(E)
- [4] Technical Guidelines for Digitizing Cultural Heritage Materials: Third Edition.
- [5] National Library of the Netherlands (Koninklijke Bibliotheek or KB), www.kb.nl
- [6] Hans van Dormolen, Imaging & Preservation Imaging (HIP) www.preservationimaging.com
- [7] Metamorfoze, www.metamorfoze.nl

Author Biography

Hans van Dormolen is the author of the Metamorfoze Preservation Imaging Guidelines, version 1.0 and 2.0. He is a member of TC42 JWG26. And he is co-designer of UTT and designer of CET357. He was working as a researcher for the KB, the national library of the Netherlands. Since 2015 he is working as an independent consultant for the international heritage community. His company is called HIP, Hans van Dormolen, Imaging & Preservation imaging.