

# Manuscriptorium Image Quality

Compatibility of image data quality:  
definition and commentary

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# Introduction to the document

## **Purpose**

This document contains an account of the principles underlying the fundamental guidelines for the creation of image data. It contains a statement of the principles to be observed in Manuscriptorium and the Manuscriptorium Q compatibility criteria.

## **Anticipated readership**

This document is intended for anyone involved in the preparation of digital images of documents for inclusion in the Manuscriptorium system.

## **References**

Reference is made in the document to the following sources:

- [1] Manuscriptorium v.2.0 - analysis of the system, December 2004
- [2] Manuscriptorium v. 2.0 – the complex digital document, October 2005
- [3] Memoriae mundi series Bohemica, see URL: <http://digit.nkp.cz>
- [4] Manuscript Access through Standards for Electronic Records (MASTER), see URL: <http://xml.coverpages.org/master.html>
- [5] Reference Manual for the MASTER Document Type Definition, see URL: <http://www.tei-c.org.uk/Master/Reference/oldindex.html>
- [6] MEdit, see URL: [http://www.memoria.cz/download/medit\\_cz.asp](http://www.memoria.cz/download/medit_cz.asp)
- [7] TorXmlValid, see URL: [http://www.memoria.cz/site\\_cz/download.asp](http://www.memoria.cz/site_cz/download.asp)
- [8] jEdit, see URL: <http://www.jedit.org/>
- [9] Emacs, see URL: <http://www.gnu.org/software/emacs/emacs.html>
- [10] NoteTabLight, see URL: <http://www.webmasterfree.com/notetabligh.html>
- [11] Manuscriptoium – basics and compatibility: [http://www.memoria.cz/docs/manuscriptorium\\_basics\\_and\\_compatibility\\_ENG.pdf](http://www.memoria.cz/docs/manuscriptorium_basics_and_compatibility_ENG.pdf)
- [12] Document selection and preparation of descriptions: [http://www.memoria.cz/docs/manuscriptorium\\_document\\_description\\_ENG.pdf](http://www.memoria.cz/docs/manuscriptorium_document_description_ENG.pdf)
- [13] Manuscriptorium Image Quality: [http://www.memoria.cz/docs/manuscriptorium\\_image\\_quality\\_ENG.pdf](http://www.memoria.cz/docs/manuscriptorium_image_quality_ENG.pdf)
- [14] Manuscriptorium Technical compatible: [http://www.memoria.cz/docs/manuscriptorium\\_compatibility\\_technical\\_ENG.pdf](http://www.memoria.cz/docs/manuscriptorium_compatibility_technical_ENG.pdf)

## Projects:

- national, see <http://digit.nkp.cz/projekty/ProjektyVaV.htm>
- international, see [http://digit.nkp.cz/Projects/index\\_cz.htm](http://digit.nkp.cz/Projects/index_cz.htm)

## Image properties in the Manuscriptorium Database

For the purposes of the present document, image digitisation is defined as follows:

**Digitisation is the conversion of selected quantifiable physical properties of the digitised object to numerical values, their encoding, saving and transport for the purpose of generating other physical values in order to enable the user to experience physiological perception which is an adequate substitute for direct perception of the original.**

In principle, this process involves loss, because it replaces a virtually infinitely complex physical reality with a few numbers with a very specialised goal – the possibility of re-creating an image for our eyes. The success of the process is evaluated holistically and always from the standpoint of the goal declared in this definition.

In accordance with the above definition, Manuscriptorium gives priority to results in terms of fidelity and quality in image capture and reproduction over subjective aesthetic and artistic viewpoints. However, mastery of the technical process naturally leads to results which can be effectively applied for subsequent creative purposes.

Two primary quality levels have been established. Our fundamental quality standard is that achieved by images unequivocally fulfilling the criteria for inclusion in the Manuscriptorium Database. The main prerequisites are unedited and unamended acquired images of adequate definition, correct lighting by a light source of specified properties and reliability of colour calibration information.

Confirmation of this quality level is a warranty of the specified compatibility of the image with the original.

Other images not conforming to the above mentioned compatibility Q technical criteria are also incorporated in Manuscriptorium; however, these images have particular significance in their field. They may be unique images of documents which are no longer extant or accessible, secondary copies of other copied images, for example digital copies of microfilm. Images with such compatibility Q status are separately identified in the database.

### Primary images (Excellent)

The fundamental images are those created at the optimal quality standard on initial capture. Fundamental images are to be created in such a way as to reduce to a minimum the probability that the photography will have to be repeated at some time in the future. A **primary image** is preserved in the condition in which it was captured, i.e. without adjustment, re-calculation or other intervention or retouching. In particular, undocumented intervention involving subsequent compensation for technical properties of the photographic technology, enhancing the subjective impression of the image (focusing, brightness adjustment, gamma,...) is inadmissible. The only permissible intervention in respect of the image is calibration at hardware/firmware level, e.g. calibration of sensitivity and white colour balance (ideally full-frame). We consider it an error to subject the image to adjustments of any kind which can be applied at any time in the future with the same or with better results. We consider that any undocumented adjustment to the image represents a loss of information.

The image encoding is selected to prevent any alteration to the information occurring when it is saved or re-generated, unless this is comparable to or approaches the natural fluctuation of primary values (see [Compression in image encoding](#)).

**Primary images** serve future security, reproduction and reprographic purposes, as a substitute for the original for all users who have an interest in the information content of the displayed document. These images are used to generate images of lower quality, optimised for their respective purposes, usually subject to considerations of available technical facilities and access strategies.

Not all **primary images** may be accessible in Manuscriptorium; however, their existence and their properties are a warranty of the reliability of the derived image data accessible in Manuscriptorium.

## Resolution

**DPI** (dots per inch) resolution is defined as the number of dots in a digital image representing a segment of a real object 1 inch (2.54 cm) in length. A dot in this small segment is created in a digital image by an area of homogeneous colour, usually a square. All details in this area are ignored and the area is usually described by a set of three digits expressing the mean photometric properties of the surface in three narrow segments of the spectrum corresponding to the colour sensitivity of the human eye (RGB).

In the above definition the decision concerning the selection of image resolution represents the maximum essential reduction of information about the digitised object. The resolution should be set so as to fulfil the following purposes:

1. The author's viewpoint – the digital image must offer a resolution level which captures all the detail the author of the original consciously wished to record in the work. It does not need to incorporate details arising unintentionally, e.g. as a by-product of the technology involved.
2. The user's viewpoint – the digital image must offer the user at least as much detail as can be seen in the original at a normal distance. The image must enable the creation, using appropriate reprographic techniques, of a copy of such quality that the subjective perception of the original and of the copy are comparable under conditions intended for the original.

### *Practical examples:*

The typical resolution for ordinary books is 300 DPI or higher. A lower resolution may be used for documents and books intended for viewing at a greater distance (antiphonaries) with no additional details such as annotation.

Higher resolution is to be applied to engravings, so that even fine grooves (including their starting points) should be distinguishable from the background of the digital image at a width of at least two distinct dots (pixels).

Higher resolution is to be applied to take account of the finest intentionally created details (for example the annotation mentioned above) so as to represent the finest line of the writing by at

least two dots clearly distinguishable against the background, the smallest written character to be represented by no fewer than 20 dots in height. Full resolution is considered to be achieved when each individual dot is created in RGB colours independent of immediately adjacent pixels.

If the colour is calculated from the wider surrounding area (colour masking in one-shot cameras) the technical resolution of the image may be evaluated as up to 1.4 x lower. As a matter of principle, the number of dots must be achieved during capture, without subsequent re-calculation. A correct image is considered to be one in which a natural contrasting line (for example the boundary between black and white areas) is represented by three pixels as a maximum, a white, a grey and a black, the greyscale level varying within the black/white range according to the position of the boundary. If this is not achieved, the resolution is in practice usually lower.

## Image format

We distinguish between the format in which primary images are saved and formats for derived images.

### *Primary images*

In Manuscriptorium we require **primary images** to adopt formats in which:

1. the format definitions are standardised and in the public domain,
2. tools for the creation and reproduction of images in these formats are included in standard computer software packages,
3. images in these formats are convertible without restriction to other formats.

We consider unsuitable all formats

1. with no freely accessible declaration of the format,
2. which require the purchase of a licence for their creation or their use.

In the Manuscriptorium Database we use the TIFF format for capture and processing and JPG with limited compression for the saving of primary data.

In the Manuscriptorium Database we do not use the PDF format for **primary images**.

In the Manuscriptorium Database we do not use formats with separate processing and image compression in the assumed information layers (script, background) for **primary images**.

### *Derived images*

Derived images are treated as temporary and the purpose of their production and use is dependent on currently available and applied technical and programming resources. It is assumed that these images can be re-generated at any time in the future from the primary images. Preference is given to formats which do not require the user to install special tools (programmes, plug-ins,...) .

## Compression in image encoding

In digitisation, **compression** is assessed with regard to the entire transfer process in accordance with the above definition and in accordance with the section on resolution. In this sense, the greatest **compression** is the substitution of an inter-connected and very subtle reality by information relating to a small number of selected average properties of chosen facets, usually captured from a single direction. The original, as yet unencoded **primary image** is clearly burdened by an extremely high level of information loss by contrast with the physical reality. The extent of this loss is determined by the selection of specific technology and its setup. Reduction of the colour information carried by all light reflected from the captured object is also an extremely lossy compression, expressing in three digits the light energy in the segments of the spectrum corresponding approximately to the sensitivity of the human eye (subsequently “RGB”).

In the project we permit the use of **lossy compression** when coding the images to be saved, because it is negligible by contrast with other information losses and inaccuracies, including those referred to above, and in practice it usually even facilitates a reduction in the overall loss of information content, since from a technical point of view it leads to easier and cheaper use of a higher resolution.

The difference between a captured, as yet unsaved, image and an image reconstructed from the saved file employing lossy compression takes the form of more or less random fluctuations. Fluctuations caused by compression are superimposed on the fluctuations which are always present in an image and which are evoked by other factors. The predominant fluctuations mask the less significant ones. The numerical RGB values are adversely affected in the reproduced image by the following fluctuations.

### *Fluctuation resulting from digitisation*

The medium of objects digitised under the project is typically paper or parchment.

The elementary digitised area is always larger than the recognisable physical structure of the medium<sup>1</sup>. Therefore, a change in the selection of this elementary digitised area, which is comparable with the size of details in the physical structure of the medium, leads to a change in individual RGB values. Re-capture does not result in identical RGB values in the relevant pixels, even though the subjective perception remains unchanged.

This fluctuation is ideally randomly distributed; it is inevitable and it is generally acceptable.

### *Fluctuation resulting from superimposition of noise*

All photographic equipment is limited in its sensitivity to the dimensions of the captured elementary light-sensitive element (usually CCD). Reduction of the dimensions of this element enhances the image resolution; however, sensitivity is much more sharply reduced and the incidence of heat **noise** in the useful signal increases<sup>2</sup>. The setting selected is a compromise between these limitations. The setting usually accepts a certain noise level in dark areas of the image. This noise level is never zero.

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<sup>1</sup> The object to be digitised in the meaning of the definition is information recorded on a medium (paper, parchment etc.) not the structure of the medium itself.

<sup>2</sup> This is one of the main differences between small-scale and large-scale cameras. Usable quality is not determined by the number of pixels alone; no less significant is the dynamic range of the image – the contrast between the maximum brightness levels that can be reproduced and thermal noise. This contrast falls off very sharply as pixel size is reduced.

The amplitude and nature of these fluctuations is dependent on the technological properties of the capturing element. Image quality can be enhanced by more intensive and longer exposure; however, this is undesirable for the captured objects.

### **Fluctuation under compression (encoding)**

This concept is introduced here intentionally, in order to establish a connection with other random factors influencing RGB via entirely different mechanisms and to make the mutual masking of these factors more comprehensible. Fluctuation under compression means the difference between the image before the application of compression and the image as reconstructed after compression. This fluctuation can be reproduced with precision (unlike both previously mentioned fluctuations), but their effect on the image is similar. Fluctuation under compression is zero in lossless formats (TIFF, BMP,...), which result in very large files in the case of RGB images. If compression enables the use of a higher resolution in practice (reducing file size) and at the same time the fluctuations resulting from encoding are lower than those resulting from digitisation and from noise, the use of lossy encoding is entirely justified.

In principle, lossy compression may be used in the processing of a fundamental image only on final saving. It may not be repeated during the technological process.

Low compression in JPG format takes the form of random noise, spatially bound to the edge area. From this standpoint we consider a compression in the encoding of primary images acceptable where the educated eye does not perceive a distinguishable change in the primary image even in the most unfavourable cases (sharp, highly contrasting edges).

For derived images we permit a perceptible change in the image resulting from compression, but any alteration or suppression of information that could mislead the user is unacceptable<sup>3</sup>.

The effect of intentional compression may be insignificant in comparison with other inevitable or ignored sources of fluctuation and error<sup>4</sup> and it may enable a significant reduction of information loss on selection of the resolution level.

## **Lighting and colour calibration**

The equipment should be set up so that the correct brightness setting of the primary image is a direct result of the capture process. Primary images should be produced on equipment with known properties in terms of colour interpretation, ideally with an individual ICC colour profile. The images must be preserved in the original captured form with the accompanying ICC profile recording the present state of the document and the properties of the lighting in use.

We consider it ideal to create colour calibration tables using non-glossy primary colours, for which reliable photometric measurements are available. These calibration images and the measurement results must be usable for the creation of an individual ICC profile and they can be attached to the images of the document together with the results of the photometric analysis. Gretag Macbeth tables, or similar, are considered appropriate. We consider calibration tables created by mixing of primary colours and photographic techniques unsuitable.

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<sup>3</sup> The higher compression levels involved in the use of JPG cause deterioration of edge areas (script and its components), but damage remains proportional to the compression level applied and the original image, and there is no loss of objects. When formats are used which compromise „in layers“ (DJVU, JPG2000,..) higher compression ratios may result in indisproportionate suppression of objects which, though not sharply defined, are significant in terms of information.

<sup>4</sup> Errors in captured images resulting from inconsistent colour properties of the lens ( without white colour balance across the whole area) may typically exceed errors resulting from compression

With regard to the nature of the document we consider adequate colour depth to be 24 bit RGB, i.e. 3x1byte for each colour. The lighting must be set up so that the brightness range of the calibration table used to generate the ICC profile covers the dynamic range used, 0-255 levels for each colour. For particularly dark documents the exposure may be intentionally increased, but it is essential to suitably document intervention in the calibration.

## Dimension calibration

Document compatibility requires definition information (DPI) to correspond to reality with an accuracy better than 1%. The fact must be demonstrable by at least one image of a measuring ruler placed on the document.

## Exceptions

Images of poorer quality may be used under the project only in the following circumstances:

- **The original is no longer extant or it is inaccessible.**
- **The original is damaged**  
and the image records lost information. Then it is appropriate to make available a fundamental image of its present condition and a separate older image.

## Identification of images

The naming of images and their incorporation in Manuscriptorium is described in the [\[14\]](#).