Preserving Technical Photo Metadata

Objectives for Technical Photo Metadata

Technical photo metadata within the scope of this paper are:

- Digital camera manufacturers' metadata, including all Exif and MakerNote metadata
- ICC metadata in the form of ICC profiles, if embedded
- Other third-party applications, for example, GPS-, face detection-, Photoshop- and Fotoware metadata
- File format metadata like that in Exif DCF2, camera RAW, JPEG 2000 or JPEG XR.

All these forms of technical metadata should be preserved, in addition to all other such as contained in the IPTC Core, IPTC Extension or IIM metadata.

Why do we need to preserve technical metadata?

Today, technical metadata must be viewed as being just as important as IPTC metadata. No one has any reservations anymore about the importance and the contribution of IPTC metadata to the business of picture agencies, news reporting and heritage works.

The prime reason to preserve and maintain technical metadata is to take advantage of technical developments and digital photography. Workflows need to be faster and more efficient, saving time and money whenever and wherever possible, image quality needs to be higher, and search and retrieval for images needs to be more discerning and more fruitful.
The digital present and the digital future require a general all-round improvement in the use of resources and digital assets.
A more complete discussion regarding the benefits of keeping technical metadata is given in an extended version of "Preserving Technical Photo Metadata" available here[1]. After reading this document, it should become clear that there is much to be gained by keeping all metadata and the highest advantages can be obtained at low cost through automatic software procedures.

Photo Workflows

Whenever photos are captured by digital cameras, metadata is written into the image file. Subsequently, additional metadata is written by the photographer, picture desk editor, picture librarians and also automatically by application and system software.
Software applications need to be aware of metadata that has been added to the image by, firstly, the digital camera and, secondly, by other people or another application, so that a complete record of metadata is preserved and preserved with each image as it passes through every stage of the workflow.

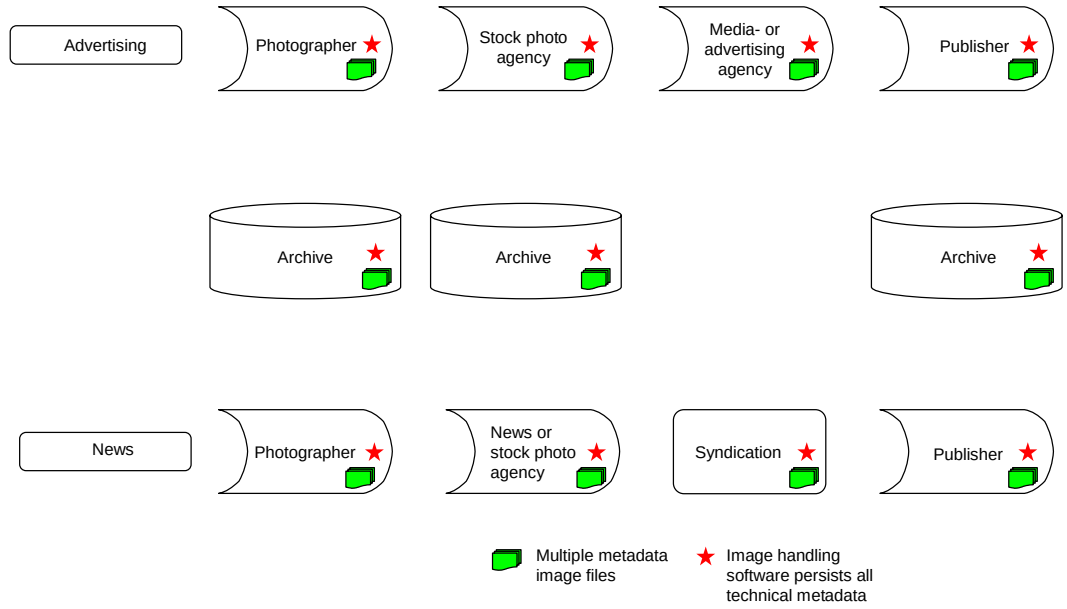
How to preserve metadata in different workflows

Workflow diagrams are shown here for the preservation of technical metadata for:

a) the general case
b) a news picture agency
c) a newspaper

The workflow diagrams have red asterisks show where metadata can be invalidated or lost, if the software application does not fully support technical metadata by updating certain fields after processing and correctly writing the metadata into the image file on saving.

Generalised Photo Value Chain



At ever stage, even when downloading images from the camera to a storage device and at every stage of picture annotation and editing, only software that preserves and maintains all photo metadata should be used.

News Agency Workflow Diagram

(dpa Deutsche Presseagentur)

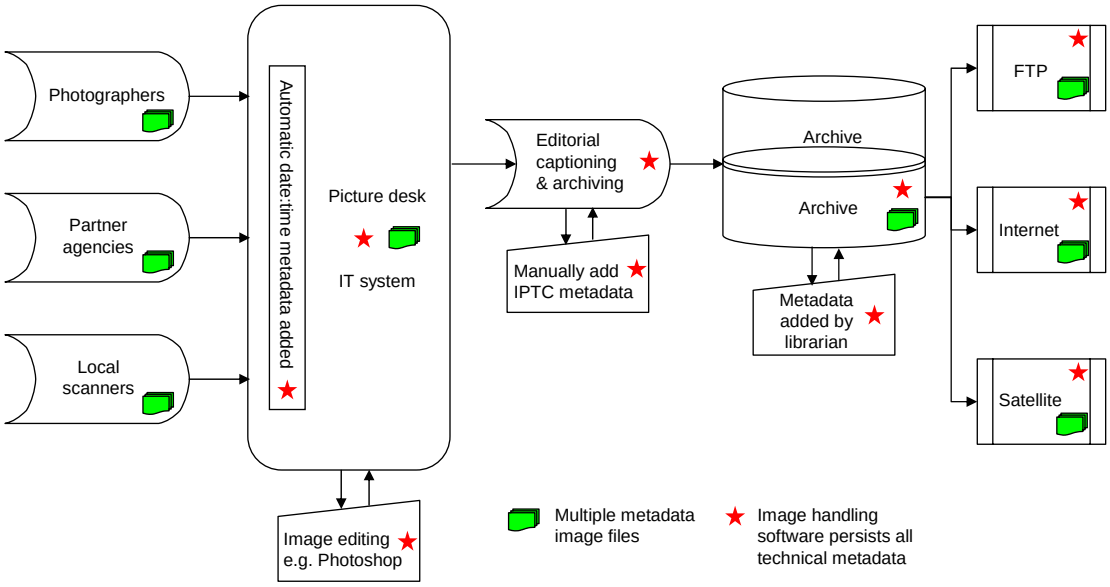
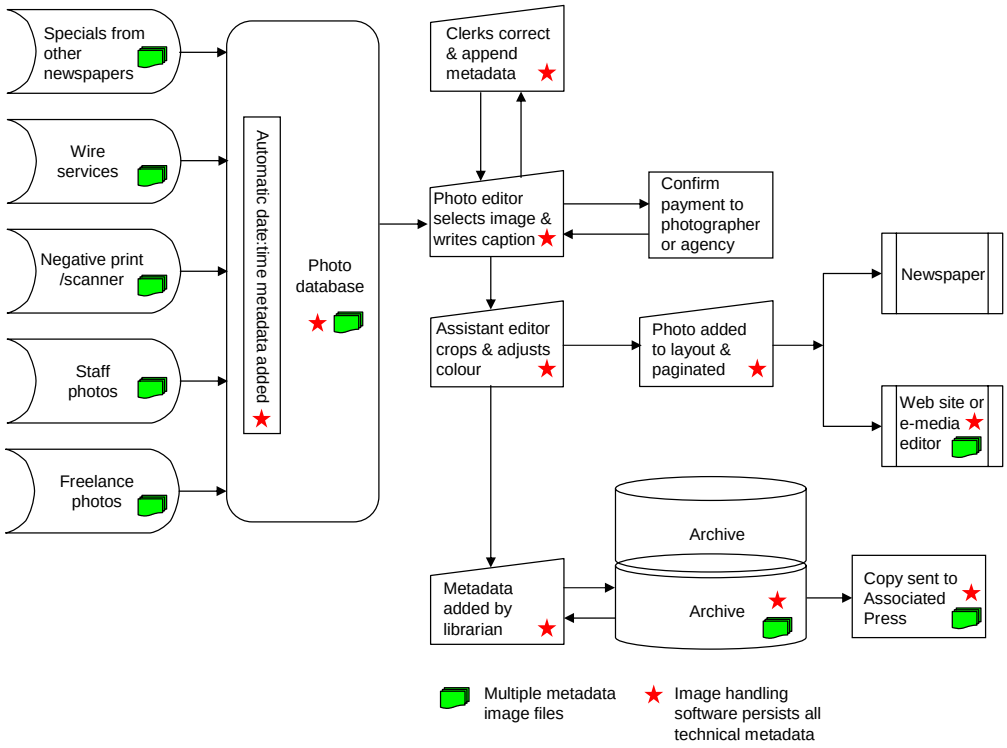


Photo Workflow in U.S. Newspapers



Recommendations

1. Preserving technical metadata means all metadata properties and their values relating to:
   - Basic file management (e.g. file type, number of image pixels in the x and y directions, orientation, image data compression parameters) MUST BE PRESERVED AND MAINTAINED to record the current state of the image
   - Administration (e.g. date and time of capture, creator, copyright holder, GPS, unique image ID) MUST BE PRESERVED AND NOT CHANGED
   - Camera settings (e.g. auto- or manual exposure, auto- or manual focus, colour space and colour profile, ISO setting, scene type, camera ID, lens ID) MUST BE PRESERVED AND NOT CHANGED
   - Image capture conditions (e.g. exposure time, lens aperture, distance to subject) MUST BE PRESERVED AND NOT CHANGED, and
   - Descriptions (e.g. comments, title) are to be added and ARE OPTIONALLY PRESERVED AND EDITED.

2. All metadata, descriptive, administrative and technical, should be preserved in accordance with the first recommendation, above, as long as each image file remains digitally accessible. All JPEG-based Exif, TIFF/EP and camera RAW files contain technical camera metadata. PDF files also contain technical metadata, as do the new generation of file formats, JPEG 2000 and JPEG XR.

3. All technical metadata should be preserved, even if they are not required for use by the current application in a workflow step. Any application should not be limited by inadequate metadata processing of software in a previous workflow step. It should not remove any property.

4. Versioning metadata, to historically record all modifications to the image, is optional. Similarly, an application must be able to update standard metadata, where appropriate.

5. If the picture data is edited, for example through orientation, colour characterisation, sizing or cropping, then the pertinent metadata (e.g. pixel height and width) and the thumbnail image need to be updated in the file to be commensurate with the main picture data.

6. Image suppliers should preserve all of the technical metadata, both standard and proprietary, in its existing and standardised form within the respective image files (Exif, TIFF, JPEG 2000, RAW, PDF, DNG etc.). Not just one schema for metadata has to be supported today, but several - IPTC IIM and IPTC Core, TIFF, Dublin Core, Exif, ICC and others.

7. In order for the technical metadata to be usable by the widest range of existing applications, technical metadata is required in its original schema. The Exif format, for example, is by far the most common digital camera format and schema for digital pictures. All automatic image

processing applications cater first and foremost for this format and schema, while extending their capabilities to other less common formats as well. Technical metadata originating from the camera-, ICC profiles-, GPS information- and face detection metadata should remain in the schema in which it was originally created by the camera or application. This would ensure maximum compatibility with clients' and customers' systems and workflows today.

If technical metadata is repeated in another schema within the same file, the metadata should still be preserved to its fullest extent in its original schema. Additionally, any updating of a metadata property that becomes necessary in one schema, for example because of, image processing or administration, should be automatically replicated by the software in each of the other metadata schemas where the same property appears in that file. Without this assistance, photo agencies have problems in keeping multiple sets of the same metadata current and synchronised within the file.

8. For the future, the use of a single schema for all metadata is to be recommended, but not until such a schema is approved by all bodies that issue imaging file standards (e.g. ISO, IEC, ITU, JEITA, JPEG, ICC).

9. Archived images should be a copy of the original picture data and full metadata so that, as the use of technical metadata develops, it shall become possible to take advantage of new algorithms to further improve image quality, the use of image resources and asset management.

10. Technical metadata and the associated image pixel data should always be kept together or be linked together in an unambiguous manner.

11. While the preservation of all metadata is the prime goal, metadata that contravenes personal information data protection, or personal-, state- or national security may be removed because of legal requirements. Software that captures all metadata must contain functions that allow the deletion of sensitive metadata, if it contravenes just one of these principles. For example, under some circumstances, a personal ID and GPS information could both be considered safety hazards to a photojournalist in the field and must be removed before distribution.

12. When organisations create or support formats for photos or picture standards, they should ensure that the respective schema or format can be read or be written by freely available software, preferably under an Open Source Licence.

    This would enable the reading and writing of image data and metadata so that the above recommendations are met, while obtaining such software should not then become expensive[2]. Only when such software is freely available and easily integrated into picture-handling programs, can the agencies and organisations which are currently unable to take

advantage of the technical developments in digital photography expect to participate effectively in an international trading of pictures.

Appendix A

The IPTC descriptive and administrative photo metadata is already under review to further improve it as the definitive form of administrative and descriptive image metadata. Technical metadata plays at least an equally useful role in today's visual extravaganza of print, Internet, mobile information, TV and community journalism, inter-activity and global communication.

Today's photojournalists, with their professional digital cameras, can capture "the moment" with superb speed and quality, and a full complement of technical metadata. Other picture suppliers such as cell phone and pocket cameras have fewer pixels, but still a semblance of technical metadata that can help with improving the image. Frequently, it is these less professional images that require the most processing.

The benefits of preserving technical metadata include:

1. Making good economic sense to capture as much metadata as possible at the start. Entering metadata to describe the image contents at a later stage is expensive.
2. Enabling colour management to improve image quality and consistency.
3. Assisting in the rapid processing of images by supplying objective data during automatic image analysis and correction.
4. Similarly, achieving a greater consistency between the pictures by contributing this objective data to such automatic processes as colour management, adaptive differences in sharpening of faces compared to vegetation or removal of colour bias due to lighting.
5. Refining search and retrieval operations.
6. Providing a means to employ "future" digital image technologies.
7. Helping in the automatic routing of pictures in a workflow, based on the creator, camera ID and job assignment ID.
8. Enabling each picture to have a unique image identifier for image tracking.
9. Providing a point of reference for the verification as to the originality of the image and metadata, if needed.

As can be seen, there are many reasons for supporting technical metadata, but perhaps the first and strongest reason has been the concept of improving images by using automatic image processing programs aided by technical metadata, the Exif and Exif Print concepts.

Exif technical metadata

An example of technical metadata is Exif technical metadata, which enables and supports:

1. File and JPEG compression parameters to handle the image correctly. For example, 4:2:2 are the exact ratios of lightness-to- chromaticity sampling used for the data compression. These are important parameters whenever an image is decompressed or recompressed. If this metadata is not available and the wrong sampling ratios are used, the deterioration in the image quality during successive compression/decompression cycles of an image data is dramatic.
2. Adequate pixel resolution for the purpose. Low resolution images that will not give good results in print can be identified from the pixel resolution metadata. This is valuable search and retrieval information.
3. Automatic image orientation. Many cameras can record the exact orientation of the camera body in relation to the subject so that images can be automatically rotated to re-establish the correct position of the scene.
4. Automatic colour management for maximising the colour range, tone reproduction and, generally, the colour appearance of the final image displayed on the screen or output on paper, thus bringing it closer to the photographer's intentions.
5. Scene recognition. When the context of the image is understood, appropriate image correction and enhancements can be applied so that the photograph can be shown with the best quality possible. Descriptions of the original image as landscape, portrait, night scene or another description can often be referenced to a camera 'mode' setting. Night scene images don't then need to be treated as under-exposed images, for example.
6. Automatic image processing, post camera, to improve the image quality. Technical metadata records the exact measurement parameters and camera settings at the time the image was captured. That is, corrections to the image can be modulated according to real-time objective measurement data rather than performing post-camera image analysis and making guesses or approximations regarding the image contents and quality.
7. Camera body ID and lens ID for better workflow and quality. If the camera ID is known, images from this camera can be directly routed to the appropriate job folder at the newspaper, for example.
8. Automatic correction for lens aberrations (colour artefacts and distortions). Many lens aberrations can now be automatically corrected by software that references the metadata concerning the make and model of the camera and the exact make and model of lens used for the image capture together with correction parameters from a database.
9. Job ID identification allows for control of billing and payment.
10. Original photographer ID identification for copyright control.
11. Unique image ID identification, again for copyright and licensing control.
12. Date/time stamping for better search and retrieval.
13. Global Positioning System (GPS) metadata for accurate location and better search and retrieval.
14. Automatic face detection metadata for better search and retrieval.

15. Automatic face recognition metadata for better annotation, search and retrieval.

The following are based of the examples mentioned above, laid out as a table of Exif metadata tabs and their usage. However, both the above descriptions and the table below fall far short of showing the extent of the Exif metadata and its uses.

Tag name	Usage in a news photo workflow
Version ID	Aids location of specific metadata
Exposure time	Brightness compensation
Flash	Brightness compensation
Subject distance	Used to estimate extent of available flash light or degree of sharpness for a specific lens and aperture
Light source	Colour compensation
Exposure mode	Brightness compensation
White balance	Colour balance compensation
Scene capture type	Processing according to the scene
Normal	Normal processing
Landscape	Enhancement of contrast, saturation and sharpness
Portrait	Memory colour correction of skin colour
Night scene	Inhibition of soft tone correction Noise reduction
Custom image processing	Prohibition of duplicate processing
Digital zoom ratio	Sharpness adjustment
35mm film equivalent focal length	Panorama stitch
Gain control	Noise reduction
Contrast	Contrast adjustment
Saturation	Saturation adjustment
Sharpness	Sharpness adjustment
Subject distance range	Noise and sharpness improvements
Image unique ID	Image tracking for copyright control
Capture conditions Exposure time 'F' number	Specification of mode
Capture contrast Capture saturation	Specification of correction values for contrast, saturation and sharpness
Gain control ISO speed rate Digital zoom magnification	Specification of noise reduction level
Exposure program Metering mode	Tone curve
Exposure correction setting	Brightness correction - tone curve
Image orientation	Image orientation
Location	Search and retrieval
Date and time	Search and retrieval
Camera manufacturer Camera model Lens ID Focal length Distance to subject	Lens aberration correction
Unique image ID	Image tracking
Colour space	Colour management
ICC profile (embedded or attached)	Colour management
GPS data	Search and retrieval
Face detection coordinates and measurements	Search and retrieval

A large amount of additional technical metadata can often be found in a section of Exif metadata reserved for the camera manufacturer's own use, called MakerNote metadata. This MakerNote metadata area may be differentially coded to the Exif standard and, therefore, must be differentially decoded before becoming useful.
Nevertheless, this MakerNote metadata contains more complete camera-specific, custom descriptions and often more precise measurement values of the camera settings than the standardised Exif metadata fields, which are also in the same file. The standards for Exif metadata[3] define the description, the metric and the precision. MakerNote metadata has no such limitations. Again, MakerNote metadata is valuable objective metadata.

The Exif and Exif Print concepts versus camera performance

Exif, the concept, requires that the digital camera records key technical metadata about the camera settings used in taking a picture, alongside the image data. Later during processing in a photo print finishing lab or when printing to a colour printer, image processing software can analyse the image data to determine the contents and use the technical metadata to moderate imaging enhancing functions before printing the results on high quality photopaper.

In the mid-1990's, this post-camera processing was needed as the necessary computing power and high quality image processing algorithms were not available inside the cameras. The computational time would have required far too long. Sport and fast action photographic images could not be fully optimised within the camera.
However, steady advancements have been made in digital camera technology and in image-enhancing algorithms. Today's cameras are much more capable, in both computing power and image processing terms. Nevertheless, sensor pixel quantities and frame rates (pictures/second) have been climbing steadily, too. Also, many other in-camera processes have been added to digital cameras to improve picture quality: predictive auto focus, auto exposure, flash calculations, anti-camera shake, automatic white balance, advanced colour processing, dust removal, segmentation, face detection, red eye removal, image noise reduction, sharpening, and others. All this can be done in addition to the other camera functions of a/d conversion, demosaicing, image data compression, memory and data transfer operations.
The result is that the high-end professional digital cameras can now produce truly high quality results at high resolution. Their maximum frame rates of 10 frames/second are now more than three times faster than motor driven film cameras of the past.

The factors that work against these advancements are that news pictures are seldom taken under ideal conditions of lighting and composure; real world conditions are totally unlike studio conditions. Rapid shooting is often a necessity. It is not a question of the photographer having to anticipate the 'moment' in time. Rather, for most instances, the professional photographer needs to take a sequence of images from which the best image can be

selected afterwards. Many times, the camera may be working at the limits of its performance.
Significant, too, is that all of the camera's many image processing algorithms are a compromise of speed, quality, integration and cost of implementing the algorithms in silicon or firmware. In every case, speed differences of milliseconds ultimately have an impact on sales of the product in the market place.
Not to be forgotten, finally, is that not all photographers have the latest and best equipment and also, occasionally, some news-worthy pictures are very poor quality taken by non-professionals, but the pictures are to be published nevertheless.

The case for using technical metadata with post-camera automatic picture processing

Nearly all digital camera images can be improved even further post-camera, in a less time-critical environment using high quality algorithms.
Technical metadata provides support to automatic image processing software which reads this information. The various details that were recorded when the picture was taken can thereby be taken directly, whereas before, such information was obtained through a process of subjective evaluation. Consequently, by using metadata, images can be optimised to improve on the camera's performance and to better reflect the photographer's intentions.

Automatic image processing is still a developing field. New applications and new algorithms pull together seemingly disparate Exif technical metadata e.g. scene type and exposure values or lens model and distance to subject. It is not known which recorded technical metadata parameters may be usefully combined in future improvements.
A leading camera manufacturer attaches three times as much proprietary (MakerNote) Exif metadata information compared to the quantity of standard Exif metadata information which is also attached.
Automatic image processing also means greater consistency among the processed images. The suppliers have enough experience to the point where they understand the required processing better than the individual picture editor.
Good examples of where automatic image processing can help manage high volumes of pictures are the news agencies and newspaper media groups where some are receiving between 10,000-15,000 pictures into their image libraries daily. News picture agencies are also delivering between 1,000-2,000 pictures daily to their customers.
High throughput, tight schedules and sometimes extensive re-processing are the reasons behind the need for automatic image processing software installed on computer workstations in the news media.

[1] http://www.ifra.com/Preserving_Technical_Photo_Metadata.pdf
[2] An example of such software is Phil Harvey's ExifTool to be found at: http://www.sno.phy.queensu.ca/~phil/exiftool/
[3] http://www.jeita.or.jp/english/standard/list/list.asp?cateid=1&subcateid=4