Automatic Exposure: Capturing Technical Metadata for Digital Still Images

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Abstract

Automatic Exposure, a new RLG-led initiative, seeks to minimize the cost of technical metadata acquisition and maximize the cultural heritage community's ability to ensure long-term access to digital assets. The project pursues a two-fold inquiry: it engages manufacturers of high-end scanners and digital cameras in a dialog about how their products can automatically capture technical metadata and make it available for transfer into digital repositories and asset management systems. Furthermore, it identifies existing or emerging technologies for harvesting technical metadata developed at individual institutions or by the industry, and explores how those tools could be leveraged to serve the entire community. The goal of the initiative is to lower the barrier for institutions to capture the data elements proposed by NISO Z39.87-2002 (AIIM 20-2002): Technical Metadata for Digital Still Images [Draft Standard for Trial Use].[1] NISO Z39.87 defines a standard, comprehensive set of data elements key to an institution's ability to manage and preserve its digital images.

Introduction

The rise of the Internet in the mid 1990s afforded museums, libraries and archives the opportunity to provide unparalleled access to their collections through the new online medium. The case in favor of digitizing unique and rare cultural objects is still compelling: 24/7 availability of collections which before could only be accessed through travel, or not accessed at all by the general public. The vast majority of museum collections, for example, cannot be found on gallery walls, but in basements and storage facilities, hidden from the public's eye. Funding from private and federal sources has produced an astonishing amount of digital images, served up on museum, library and archive Web sites, or integrated into union resources such as RLG Cultural Materials.[2]

While digitization provides a radically new way for cultural heritage institutions to fulfill their core mission of providing access to the cultural memory of humankind, it also throws into relief a familiar challenge in a new guise. The cultural heritage community has ample experience in preserving physical artifacts, and has taken on the preservation of digital materials with a similar level of commitment. The high cost of the digitization process and the stress it puts on sensitive materials has given rise to the sense that only access in perpetuity can justify the cost of digitizing collections. Cultural heritage institutions have adopted the approach of capturing one image at very high resolution for a multitude of uses over time. The digital images museums, libraries and archives create are digital assets, or in other words, investments they need to manage and preserve, just as they need to manage and preserve their physical collections.

Since concerns of longevity and preservation are deeply engrained in the cultural heritage community, the new digital challenge has propelled museums, libraries and archives into the forefront of research into digital preservation. One of the milestones in the emerging digital preservation framework is a target data set of technical metadata for digital images proposed by the draft standard NISO Z39.87. It defines a comprehensive set of data elements that are key to an institution's ability to manage and preserve its digital images. In June 2002, NISO Z39.87-2002 (AIIM 20-2002)[3] was released as a Draft Standard for Trial Use to allow eighteen months of implementation and comment. At the beginning of 2004, the draft will be revised and balloted, becoming a fully-fledged National Information Standards Organization (NISO) standard in the process.

Technical Metadata and its Context

While technical metadata is only a subset of the complete suite of preservation metadata necessary to achieve the long-term viability of a digital asset, it has often been called the first line of defense against losing access. Technical metadata assures that the information content of a digital file can be resurrected even if traditional viewing applications associated with the file have vanished. Furthermore, it provides metrics which allow machines as well as humans to evaluate the accuracy of output from a digital file. In its entirety, the data set supports the management and preservation of digital images throughout the different stages of their life-cycle.

The NISO Z39.87 data dictionary covers four distinct categories of functions:

- **Basic image parameters** record information crucial to displaying a viewable image.
- **Image creation** metadata records information crucial to understanding the technical environment in which a digital image file was captured.
- **Imaging performance assessment** metadata records information that allows evaluation of the digital image's quality, or output accuracy.
- **Change history** metadata records information about the processes applied to an image over its life cycle.

The data elements within the sections build and expand on technical metadata available in TIFF Rev. 6.0, TIFF/EP, and EXIF file formats, as well as metadata elements from the Digital Imaging Group's[4] DIG35 metadata element set. While NISO Z39.87 itself is agnostic in terms of implementation, NISO commissioned Library of Congress to create an authoritative XML implementation called NISO Metadata for Images in XML Schema (MIX).[5]

The cultural heritage community has already established a framework for digital preservation, and the parts fit together to form a mature strategy. Using the terminology established by the Open Archival Information Systems (OAIS),[6] technical metadata (as part of Representation Information) finds its place alongside the components of Preservation Description Information (Reference Information, Provenance Information, Context Information and Fixity Information) in a fully fledged preservation repository. Or, for those more familiar with the way Metadata Encoding and Transmission Standard (METS)[7] slices the metadata pie, technical metadata becomes part of the administrative metadata, alongside rights, source and digital provenance metadata. The OCLC-RLG Preservation Metadata: Implementation Strategies (PREMIS)[8] working group is in the process of creating a comprehensive data dictionary for preservation metadata independent of file format. Since technical metadata is file-format specific, NISO Z39.87 will complement the all-encompassing PREMIS effort for data sets comprised of digital images. However, putting digital preservation into practice still requires economic ways of data capture.

The *Automatic Exposure* Initiative

The imminent availability of a mature standard for technical metadata, coupled with the pressing demand for capturing metadata supporting digital preservation economically, create a timely opportunity to investigate the practical issues of using the NISO Z39.87 data dictionary. The *Automatic Exposure* initiative helps institutions meet the technical metadata imperative by pursuing a variety of implementation strategies. The initiative engages manufacturers of high-end scanners and digital cameras in a dialog about how their products can automatically capture technical metadata and make it available for transfer into digital repositories and asset management systems. Furthermore, it identifies existing or emerging technologies for harvesting technical metadata developed at individual institutions or by the industry, and explores how those tools could be leveraged to serve the entire community. NISO as the custodial home for NISO Z39.87 co-sponsors the initiative, and the Digital Library Federation (DLF) and the Museum Computer Network (MCN) have pledged their support.

As a first phase of *Automatic Exposure*, RLG circulated an informal survey to identify stakeholders, current practices and common equipment in the community. Despite limited circulation, we received well over 100 responses to the survey. In summary, the responses testify that capturing technical metadata tends to be a manual, time-consuming process. All of the responding institutions wholeheartedly subscribe to the value of recording technical metadata, yet only a minority has the ability to capture the technical properties of files even at the most basic level. The conundrum is obvious: cultural heritage institutions do not have the staff to hand-capture metadata vital for preservation, but they also do not have the staff to recreate the files if they lose access. Furthermore, they cannot justify the risk of damaging artwork and fragile materials through repeated handling and exposure to light. Securing long-term access to digital images emerges as the linchpin in the community's ability to continue on the path of providing broad access to collections online.

The survey fueled the subsequent activities of the initiative. Based on the information provided by professionals in the field grappling with technical metadata issues, the authors wrote a white paper outlining the problems, solutions and opportunities the *Automatic Exposure* initiative intends to investigate. The document served as the basis for discussion of a select group of cultural heritage stakeholders and some industry representatives at a meeting (co-sponsored by NISO) held in conjunction with the MCN Conference in Las Vegas November 2003.[9] Furthermore, the survey identified the prevalent digital capture devices used in the cultural heritage community, which provides the initiative with a target list of manufacturers (ranked by market penetration according to the survey):

- Nikon
- Epson
- Microtek
- PhaseOne
- BetterLight
- UMAX
- HP
- Canon
- Creo
- Agfa[10]

The top ten manufacturers cited produce devices ranging from digital cameras and digital camera backs to scanners. In addition to the top ten, the initiative also targets specialty and high-end device manufacturers that are well represented in cultural heritage institutions, though not in the large numbers of the top ten.

A number of manufacturers have already responded very positively to our invitation to participate in the initiative, among them Betterlight, Creo/Leaf, HP, Kirtas Technologies, Kodak, and Sinar Bron. A second meeting scheduled in conjunction with the Association for Information and Image Management (AIIM) Expo in March 2004 will present the needs of the cultural heritage community and the preliminary outcomes of *Automatic Exposure* to the manufacturer community at large.

Getting Industry Involved

While it admittedly is a struggle to identify the right employee at a large corporation who would be an appropriate target for information about *Automatic Exposure*, there are plenty of motivations for device manufacturers to get involved. Partnering with the cultural heritage community provides them access to one of the most active communities in the fields of digitization and digital preservation. A recent development illustrates the scope of the current investigation: in January 2003, the US legislation appropriated $100 million for a program giving the Library of Congress the responsibility of creating a national information infrastructure for digital preservation.[11] The appropriation allows the Library of Congress to fund partner institutions, identified through a competitive grant application process, who are working on pieces of the digital preservation puzzle.

The outcome of the groundbreaking work in the cultural heritage community will have a profound impact on any industry with a long-term investment in digital data, including companies from fields such as health care, entertainment and finance. Obviously, the focus on sustaining digital assets creates a market where products supporting digital preservation will have a clear advantage over products which ignore this pivotal issue. In our survey, many stakeholders volunteered that they would not hesitate to buy a camera which made metadata capture easy over a camera without that feature even at a higher price tag. Manufacturers of capture devices can position themselves with respect to this new market requirement by creating devices that will enable digital preservation at the outset. Digital preservation starts at the point of file creation with capturing technical metadata.

Some manufacturers of capture devices have already made an investment in technologies which capture and transport technical metadata. The de facto archival file format standard TIFF[12] includes fileheader tags containing technical metadata. EXIF 2.2[13] extends the mandatory TIFF tags with additional EXIF tags, and has become a popular format in single-chip cameras. The DIG35[14] element set is an integral part of the JPEG 2000 (Part 2)[15] metadata architecture, although research for this paper turned up no evidence of widespread implementation at this point. Both EXIF and DIG35 seem geared towards the consumer end of the single chip digital camera market. Three Kodak surveys from 2002 and 2003, published as an appendix to the *Automatic Exposure* white paper, show that EXIF implementation in consumer cameras (2 megapixel range) is essentially the same as for the professional cameras (3 to 6 megapixel). The special needs of high-end photography in terms of preservation have not yet had any impact on the products offered. It is hardly surprising to find that the implementation of tags that are not mandatory in the EXIF specification varies from camera to camera. For high-end digital camera backs, anecdotal evidence suggests that manufacturers use TIFF fileheaders to capture technical metadata.

Mapping NISO Z39.87 to TIFF, EXIF and DIG35

As mentioned earlier in this paper, the NISO Z39.87 data dictionary draws on the elements and terminology from the industry specifications to ensure a maximum of compatibility. To a certain extent, NISO Z39.87 can be seen as mixing and matching elements from existing initiatives. However, none of the current vehicles for technical metadata were explicitly created with digital preservation in mind, which led to the inclusion of additional elements in the data dictionary as well. A mapping between NISO Z39.87 and the existing transport specifications--TIFF, EXIF and DIG35--reveals the degree to which industry efforts satisfy the stipulations of the standard. Figures 1 and 2 were derived from Appendix 2 of the *Automatic Exposure* white paper. Please note that these preliminary mappings are based on the NISO draft standard, which may have been replaced by a modified balloted version at the time of publication.

The first table analyses the degree to which the industry specifications and the entire NISO Z39.87 set overlap.

	NISO Z39.87 *Complete*	**TIFF 6.0 / TIFF EP Mapping Elements**	**DIG 35 1.1 Mapping Elements**	**EXIF 2.2 Mapping Elements**
Basic Image Parameters	30	16	8	13
Image Creation	38	9	34	19
Imaging Performance Assessment	36	22	7	16
Change History	7	2	6	1
Total	111	49	55	49

Figure1. The quantitative result of mapping all four sections of the NISO Z39.87 data dictionary to TIFF, DIG35 and EXIF

The TIFF specification includes 49 of 111 NISO tags. It shows the most overlap with the Basic Image Parameters and Imaging Performance Assessment categories, where the NISO data dictionary draws heavily on TIFF tags.

DIG35 covers 55 of the 111 NISO tags, showing the most overlap in the Image Creation and Change History sections, which were inspired by the industry effort.

EXIF covers 49 of the 111 NISO tags, showing between 40-50 percent overlap in the Basic Image Parameters, Image Creation and Imaging Performance Assessment sections, but the concept of a Change History does not really exist in EXIF.

Figure 2 details how many of the "Mandatory" (M) and "Mandatory if Applicable" (MA) elements from NISO Z39.87 can be found in TIFF, DIG35 and EXIF.

TIFF covers 22 of NISO's 33 M/MA elements, and shows a nice spread across all the categories. DIG35 covers 17 of the 33 M/MA elements, with an especially weak mapping to the Imaging Performance Assessment tags. EXIF covers 19 of the 33 M/MA elements, with an equal to or greater than 50% mapping for every section except for Change History.

	NISO Z39.87 ***M/MA***	**TIFF 6.0 / TIFF EP Mapping Elements**	**DIG 35 1.1 Mapping Elements**	**EXIF 2.2 Mapping Elements**
Basic Image Parameters	13	7	7	9
Image Creation	2	1	1	1
Imaging Performance Assessment	15	12	3	8
Change History	3	2	3	1
Total	33	22	17	19

Figure 2. The quantitative result of mapping the "Mandatory" and "Mandatory if Applicable" tags from the four sections of NISO Z39.87 to TIFF, DIG35 and EXIF.

The preliminary quantitative reading of the three industry specifications against NISO Z39.87 suggests a glass half full or glass half empty conclusion, depending on your perspective and temperament. As a whole, the specifications match NISO Z39.87 just below the 50% mark. Looking exclusively at the most important elements of the standard, the match rate rises above 50%, and for TIFF up to a 66% overlap. The figures as a whole might turn out even a little more favorable if the analysis took into consideration that some of the elements proposed by NISO Z39.87 cannot be automatically captured. For example, unless declared by human input, the capturing software can not know what color target a photographer is using. One the other hand, in the real world, mappings become relativized by the actual implementation of each specification. Going back to the Kodak surveys, the EXIF metadata captured by a Kodak ProBack 645 (the most capable device in the line-up, with a maximum resolution of 4064x4064 pixels) only includes 9 of the 33 NISO M/MA elements.

Obviously, TIFF fileheaders, EXIF and DIG35 metadata present good opportunities for capturing and transporting technical metadata, but even in their complete implementation, they do not deliver a result satisfying NISO requirements. At the first *Automatic Exposure* meeting in Las Vegas, community stakeholders representing the J. Paul Getty Museum, Harvard University, Museum of Modern Art New York, Stanford University, University of Calgary and University of California Berkeley, unanimously voted that this initiative should seek out solutions which would give them access to no less than the entire NISO Z39.87 element set. Up to now, decisions about what technical metadata a preservation repository tracks have been made based on the ready availability of elements, and not on the community's best knowledge about what is needed to provide access to its digital assets in perpetuity. The consensus among stakeholders is that only access to all the elements in NISO Z39.87 will provide an environment in which institutions can make informed decisions based on the needs of their assets rather than based on availability.

To make this vision come true, two main issues need to be addressed. First of all, capture devices and software have to record all of the NISO Z39.87 elements. The elements should be automatically captured during file creation whenever possible; for elements outside of the realm of automatic capture, software needs to allow manual data entry or, even better, the application of capture profiles for batch-application of metadata. Second, technical metadata has to be exposed for editing and transfer into preservation systems, preferably as XML utilizing the MIX schema. The main criteria for evaluating specific transfer mechanisms for technical metadata are ease of access to the metadata, and broad availability and support for the mechanism itself. The least desirable option is to employ manipulation tools such as metadata harvesters (in case the metadata is otherwise inaccessible or sits in header tags) or Extensible Stylesheet Language Transformations (XSLT) in order to transform the offered dataset into NISO Z39.87 elements / MIX XML. Obviously, even this last strategy only succeeds if the complete NISO Z39.87 data set is available in the first place.

The remainder of this paper will outline a strategy to satisfy the stakeholder's demands based on the emerging industry technology Adobe Extensible Metadata Platform (XMP). While *Automatic Exposure* will not limit its investigation to XMP, the technology shows enough promise to warrant a close look.

A Possible Solution – Introducing Adobe XMP

While existing industry specifications, such as DIG35 or EXIF2.2, can be leveraged to satisfy a significant number of elements stipulated by NISO Z39.87, neither data set maps conclusively to the standard. An alternative vehicle for metadata not restricted to a particular element set exists in Adobe's Extensible Metadata Platform (XMP).[16] Adobe

XMP leverages existing technical metadata specifications such as TIFF, EXIF and DIG35 by extracting existing metadata and writing it to an XMP packet (an XML file stored within the original data content file). The data gathered from existing specifications can be augmented with other elements in an XMP savvy application such as Adobe Photoshop. Alternatively, device manufacturers could create devices that embed XMP packets containing the full complement of NISO Z39.87 data at file creation.

XMP is a free open-source technology available for download as an SDK. Adobe has implemented XMP across most of its product line. The technology is garnering support from third party vendors as well, and has been touted by Eric Miller of the W3C as "an important piece that brings the Semantic Web closer to realization."[17] Adobe hopes that this open-source technology will become an industry-wide standard for sharing metadata across applications, file formats, and devices. The XMP packet embedded into the files consists at its core of XML data governed by Resource Description Framework (RDF) syntax. The integrity of the original file is not affected by the packet. Specifications for where to place packets exist for the image file formats TIFF, JPEG, JPEG 2000, GIF, PNG and PSD.[18]

While Adobe XMP contains a number of pre-defined, built-in namespaces or element sets (among them Dublin Core and EXIF2.2), it can be customized to transport any metadata set. The XMP Custom Panel Description File Format lets users define their own namespaces (element sets) and how the elements appear in the interface of an XMP enabled application (layout). Once a panel has been designed, the file defining the namespace and layout can be shared among a community of users. To gain access to the desired metadata set within XMP enabled applications, the shared panel needs to be placed in a specific folder location on a local hard disk.[19]

In Photoshop CS, the panel with XMP data can be accessed through the File/File Info function. For example, importing an image from an EXIF-enabled digital camera into Photoshop, the File Info fields in the Camera 1 and Camera 2 panel will be populated with values harvested from EXIF. The File Info panels also allow editing or augmenting the data. For viewing the entire set of metadata captured from EXIF, Advanced/EXIF Properties shows all values as a list. The Save function on the Advanced screen creates an external XML file containing all the metadata present.

XMP and *Automatic Exposure*

XMP could become an important piece of the puzzle in the quest for access to technical metadata. Adobe has signaled an interest in working with the cultural heritage community, and the initiative has benefited greatly from the input of an XMP product manager. In itself, XMP will not provide the community with a more complete set of technical metadata elements, but it will expose any metadata present in the file for editing (for example, adding information which can not be recorded automatically) and it outputs the data to an easily manipulated XML file. As a first step, the *Automatic Exposure* initiative decided to create an XMP Custom panel for the namespace defined by the NISO Z39.87 data dictionary. At the very least, this prototype panel will serve to highlight gaps in the metadata currently available vis-à-vis the NISO standard. Adobe has pledged to support this effort by proofing the panel and promoting it on the XMP website.

A more comprehensive strategy to utilize XMP for technical metadata access would include the following components:

- Creating and sharing an authoritative XMP custom panel reflecting the complete NISO Z39.87 metadata set
- Consulting with device manufacturers on how to embed NISO metadata in XMP format during image capture
- Creating and sharing guidelines for (batch) exporting the metadata set out of Photoshop CS, for example as XMP XML files
- Creating and sharing an XSLT stylesheet for transforming the exported XML metadata files into the NISO Z39.87 reference implementation NISO Metadata in XML Schema (MIX)

If implemented successfully, this strategy would provide institutions with access to the complete NISO Z39.87 metadata set, both internal and external to the content file. In the community survey, stakeholders were evenly divided on where they would want the metadata to live. Some argued in favor of an internal solution to preclude separation of the metadata from the file it describes; others argued in favor of external metadata to facilitate easy export into preservation repositories. The vision outlined above provides both options. It also recognizes that the processes applied in exporting the metadata and manipulating it have to work on a batch level – repository managers want to capture the properties of entire directories of images and import them into management systems.

Conclusion

The core question of *Automatic Exposure*, however, remains: will the initiative be able to gather enough momentum to persuade device manufacturers to address preservation in their products? Apart from the promising XMP route, many other ways of delivering NISO Z39.87 to a community interested in the long-term preservation of digital assets exist. The next *Automatic Exposure* meeting in conjunction with the AIIM Expo New York, co-sponsored by NISO and AIIM, takes the issues to the manufacturers. The feedback we gather in New York will shape the approach with which *Automatic Exposure* keeps pursuing its goal to minimize the cost of technical metadata acquisition and maximize the cultural heritage community's capability of ensuring long-term access to digital assets.

References

1. For more information on NISO Z39.87, please see http://www.niso.org/standards/standard_detail.cfm?std_id=731
2. For more information on RLG Cultural Materials, please see http://www.rlg.org/culturalres/
3. From here on out, this paper will refer to NISO Z39.87-2002 (AIIM 20-2002) by the shorthand NISO Z39.87.
4. The Digital Imaging Group (DIG) merged with the Photographic and Imaging Manufacturers Association (PIMA) to form the International Imaging Industry Association (I3A) in July 2001.
5. For more information on MIX, please see http://www.loc.gov/standards/mix/
6. For more information on OAIS and its application in the cultural heritage community, please see http://www.rlg.org/longterm/oais.html
7. For more information on METS, please see http://www.loc.gov/standards/mets/
8. For more information on PREMIS, see http://www.oclc.org/research/projects/pmwg/
9. For a copy of the white paper and minutes from the Las Vegas Meeting, please see the Automatic Exposure initiative page at http://www.rlg.org/longterm/autotechmetadata.html
10. Agfa discontinued its line of desktop publishing scanners and digital cameras at the end of 2001, and therefore is not a target of the initiative's communications.
11. For more information on NDIIPP, please see http://www.digitalpreservation.gov/
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Biographies

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