

# Preservation of Photographic Images for Future Generations: New Opportunities for Prints and Photo Books

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## Abstract

*Upon discovering the 120 year old object in their grandparents' attic, most people today would be hard-pressed to play back a recording made on a wax cylinder of the late 1800s. What will people do just 50 years from now with an optical disk or magnetic hard drive? Over time, we have recorded our memories in many ways: letters, post cards, photographs, movies, audio and video recordings are a few examples. In earlier days, interpreting those recordings was independent of the technology used to create them – you could hold and view a hard copy document in your hand. How will future generations deal with those post cards, letters to the family, and photographs that have now been replaced by “Word documents”, email, and digital images on the computer? While professional and mass-portrait labs recognize the importance of hard copy images, the word needs to spread from there. The end consumer in particular needs to become aware of long-term storage issues that relate to the preservation of the data behind digital documents including photographic images. Longer-term issues beyond routine backup and migration of data need to be considered, and preservation via human-readable hardcopy images is a key option. This paper provides an update on preservation strategies for the consumer and suggestions for the professional imaging laboratories to communicate these strategies to the consumer. While the familiar advice to “make a hard copy” provides a solid foundation, we go beyond this recommendation, with the intent to raise consumer awareness of the need to create a long-term preservation plan for their most treasured images and the data behind them.*

## Introduction

As our world of photographs becomes more and more digital, there is an ever-growing concern over long-term storage and the preservation of these images, especially as it relates to the general public. While the photographic printing industry is certainly aware of this concern, the general public is not. Earlier papers by this author on the subject of long-term preservation [1, 2] have dealt with digital photographic images and the use of film as a technology-independent storage medium while a more recent paper [3] focused on documents of all kinds, including digital files of letters, emails, as well as photographs. The focus of this paper is long term preservation of the “best of the best” of consumers’ photo images through hard copy output products from the photo printing industry. The goals of this paper are to help the industry: 1) raise the general public’s awareness of long-term storage issues of digital images; 2) reinforce the value of hard copy printing of photographic images as a technology-independent, viable long-term storage solution; 3) discuss ways in which the photo fulfillment industry can assist in promoting these solutions to the general public while simultaneously increasing their revenue of photo fulfillment products such as prints and photo books.

## Current state

As personal computers, notebook/“pad” computers, and smartphones continue to grow in use, digital imaging and email become more and more popular as the primary mode of documenting lives. This creates an ever-growing concern over long-term storage and the preservation of these memories and documents. While some, perhaps many, of these files do not need to be preserved for the long term, some do. Worse, consumers often times do not recognize the importance of many of their images; for example, it may not be until a photograph is “rediscovered” 20 to 30 years later that people recognize how valuable it is. In the digital world, without proper attention now, digital documents of all kinds will simply not be available 100, 50, or perhaps even 30 years from now.

Despite efforts by photo industry trade organizations, the average consumer continues to be generally unaware that there is an underlying risk associated with information storage on computer hard drives, devices, or optical media. In many cases, because it is digital, the consumer actually feels that the information and images are safely preserved. Museums, conservators, and archivists, on the other hand recognize the problem of digital image storage. Relative to preservation strategies for large institutions, research and other published works are available on the topic [4-6]. These strategies, however, are based on shorter-term storage with an associated longer-term migration plan. While some risk is mitigated, much remains.

## Key issue: formats

Most people today would be hard-pressed to play back a recording made on a wax cylinder of the late 1800s. What will people 100 years from now do with an optical disk or magnetic hard drive? Wax cylinders were replaced by gramophone disk recordings in the early 1900s, (what we call “phonograph records” or simply “records”). This was a more robust and longer-lived technology, but eventually even records were replaced by new technology – CDs. Now CDs are being superseded by flash media in compressed MP3 format, and the whole concept of *iTunes*® and “cloud storage” could eventually replace device storage media all together. The eventual replacement of technology is inevitable. Just as one would have difficulty finding the equipment to play a wax cylinder from the late 1800s, or the equipment (turntable *and* stylus) to play back a 78-RPM record made in the mid 1920s, so too are people having difficulty finding the equipment to render a letter or document recorded on a 5.25-inch floppy disk just 30 years ago. Why would we think it will be any different in another 30-50 years when our children and grandchildren want to render a photographic image recorded on an optical or magnetic disk?

Digital technology adds several additional layers of complexities. Consider a 5.25-inch disk. To render a digitally stored image presents four distinct hurdles: 1) media format, as

mentioned; 2) interfacing to a modern computer; 3) file format; 4) data integrity.

**Media format:** because this media format has been superseded by three successive generations (3.5 inch magnetic, optical CD and optical DVD), finding a 5.25 inch disk drive may be very difficult. **Interface format:** with the advent and proliferation of the Universal Serial Bus (USB) interface in the mid and late 1990s connecting an older 5.25-inch drive will pose problems even if one can be found. If the drive has an external serial or parallel connection, connecting to modern computers will not be possible. If the drive is an internal drive it likely has an Integrated Drive Electronics (IDE) architecture which can still be found in many recent computers.

**File format:** early word processors from various companies (Wang®, Multimate®, Wordperfect®, etc.) each had unique file formats. As Microsoft Word became a *de facto* industry standard, MS Word provided some capability to translate from those formats. Today, however, due to the age of these formats, this capability is not included in recent MS Word versions. An internet search, however, can provide software or companies that do provide translator software (for a charge) to an early version of Word, which can then be retranslated by current versions. In the early days of digital photography Microsoft created a proprietary “.MIX” file format for its “Photo Draw” and “Picture It!” software, both used for consumer photo archives, which was later abandoned without any means of doing batch conversions.

**Data integrity:** is the digital data still there and readable or not? Passing this final hurdle will depend on media quality and storage conditions. Today there is a plethora of low quality, very inexpensive optical media with highly doubtful long-term storage capability. There are also high quality optical media with claimed longevity of 300 years (for CDs, 100 years for DVDs). Even if the media lasts that long, the likelihood of passing the first three hurdles after 300 years, or even 100 years, is highly doubtful.

### **Format hurdles: an example**

Consider the discovery of a 5.25 magnetic floppy disk from 1985 containing family history information. In this example we'll make it easy: the disk was in a labeled jacket containing the file name, and we also know it was created with Multimate® word processing software. Given the relatively low storage capacities and the fact that 5.25-inch floppy disks were stored in a jacket, a human readable hard copy print out of the contents of the disk were often included inside the jacket. This enables us to more easily locate a document and perhaps know its file type. None-the-less, the four hurdles remain. Not only does this example illustrate the physical format challenges, it also illustrates the file format challenge. File formats change. Not all “.doc” files are the same, nor can they be read interchangeably. Even within a company like Microsoft their Office software products evolve. Long term file formats like DOC, PPT, and XLS have recently been updated to DOCX, etc. The “X” files cannot be read by earlier versions of Office software without add-in updates. File format is a very serious concern for long-term preservation.

Finally, it also needs to be noted that the huge challenges of restoring the information in this example occurred with the passage of only 25 years. Imagine the challenges facing a consumer finding digital family photographs after two or three generations.

### **Technology always advances**

For both physical and software formats, change is driven by ever-advancing technology. Consumers began “burning” CDs when laser writing technology became inexpensive enough to drive the price of CD writers down. Then the same thing happened with DVD writers. While consumers are now burning DVDs, there is a new, incompatible DVD format from the entertainment industry, with the Blue-ray DVD format having won out over the HD DVD format. How long a particular format persists depends on many factors, including economics. An additional risk factor is the breadth of usage of a particular format, which can have both positive and negative consequences on the risk of obsolescence. CDs have been well established for many years by the music industry and could therefore be considered a long-surviving, low-risk format. However, unanticipated technology changes occur that can increase risk and shorten longevity. Music CDs are now under direct challenge from flash memory in MP3 players and smartphones. Will there be a full-scale format change? Eventually there will be. Consider VHS tape. It also became well established and actually rendered the Beta format obsolete. In 1990 it would have seemed likely that VHS was sufficiently well established by virtue of the motion picture industry that it would be at low risk for a format change. Today, of course, VHS has become obsolete by DVD technology, driven by the same industry. So risk is always present and usually cannot be predicted far in advance of a format change.

Just as media format changes are hard to predict, technology advances around file structure and format will inevitably change as well, and these improvements eventually render older technology obsolete. DVDs offered many significant improvements over VHS tape. Flash memory in MP3 players offers many advantages over mechanically driven CD players. Technology of file formats and structures continues to advance as well. With this in mind, why would we expect today's popular photo encoding format (JPEG) to endure? JPEG2000 already offers many improvements in compression over JPEG. The Windows Media Photo file format, later renamed HDPhoto, was announced in 2006 and shipped with the Windows VISTA operating system. With some fine tuning by the JPEG committee, HDPhoto has become JPEG XR and in mid-2009 became a published ISO standard (ISO/IEC 29199-2). With its improved compression algorithms, improvements in color reproduction accuracy, and support for High Dynamic Range (HDR) imaging, it is only a matter of time before camera manufacturers begin to abandon JPEG. Will JPEG file formats be readable in 2031? 2031 is only 20 years away.

### **Historical perspectives**

Many studies are available on the long-term storage of digital information [7]. The work has been driven largely by libraries, museums, and governmental institutions, and addresses the threats associated with computer-dependent systems. There is recognition of the need for ongoing data migration as hardware, software, file formats, and operating systems evolve. Because the quantity of information for these large institutions is huge, high-capacity systems are needed. Alternatives to these types of rapid access, computer-dependent systems have been studied where the ability to have rapid access is reduced in exchange for a reduction in the need for data migration. Examples that have been discussed in the

literature make use of photographic film as the preservation medium [8].

The use of film for preservation is not new, as it has been done extensively in the motion picture and document industries for many years. Polyester-based, black-and-white silver separation films enabled the creation of separate red, green, and blue records of color motion pictures that could last over 200 years in controlled, room-temperature storage. The viability of this process has been demonstrated repeatedly in recent years with successful restorations of many classic films. Black-and-white microfilm provides stability up to and beyond 500 years at room temperature with good storage efficiency. Compression of documents in the order of 25 to 45 times is possible. New hybrid document imaging systems enable the use of film with scannable metadata for enablement of automated search and retrieval functions [9].

Preservation of photographs in the home has historically centered on hard copy prints in albums, scrapbooks, and shoeboxes. In photography, there has been significant growth in digitally generated scrapbooks, photo albums and photo books in the last couple of years, and growth of these products is expected to continue. A hard copy print is human readable and therefore requires no system architecture to be put into use. Longevity of various photographic print media will be discussed later in this paper.

As consumer imaging continues its rapid advance to the digital world, preservation remains erratic or non-existent. There has been little to no thought by consumers for long-term preservation of their images. It seems they are taking for granted the automatic, "built-in" preservation that came with the traditional analog negative and print that was available for many decades. Today, digital files of all documents, including images, tend to be loosely organized on hard drives, CDs, and DVDs. But, often, there is no organization and little to no awareness of the vulnerability to loss of the image from the format and integrity issues mentioned earlier. All of these impacts result in the need for continual long-term migration of the digital data of an ever-growing digital image collection. Unfortunately, consumers in general are totally unaware of this need.

## Long term archiving

As mentioned above, archiving of digital files requires an ongoing commitment to manage records to keep them intact and ahead of any type of time-dependent changes. Considering that consumers want at least some of their images to last for many generations, if not a lifetime or more, and this requires a very long-term commitment. Migration cycles need to be short because of the rapid and ongoing advancement of the computer and associated systems and the short life cycle of the media. So how do we preserve for the long term, for many generations?

### TIP: Technology independent preservation

Technology independent preservation takes a long-term perspective and eliminates the need for short-cycle migration of digital information. The digital information (images, documents, email) is rendered to a hard copy, human readable output. Once done, a computer (today or in the future) is no longer needed to use the information. Once the document is rendered, elimination of the dependency on the computer has a positive impact on migration cycle time and allows for a preservation system that

needs infrequent attention other than maintaining proper environmental storage conditions. The migration cycle is dependent only on the long-term stability of the output media. The key is to move from a digital storage format to a human-readable format using media that are very stable.

## Preservation by consumers today

The first and simplest way is to make hard copy prints of the most valuable images, and media of various technologies exist today to provide over 100 years of storage life at room-temperature conditions. Printing is easily accomplished at home using photographic-quality 4 × 6 or page-sized printers, at retail locations using self-service kiosks or a retailer-operated digital minilab, or online. Online options are best for larger volumes of images. Many online sources are available providing prints, photo books, and photo albums and include many high quality professional labs or consumer oriented image sharing sites. The first page or so of a Google® search on "professional photographic printing" provides many sources of high quality printing. With all of the long term concerns that have already been discussed, printing of the consumer's "best of the best" images is the simplest and most reliable means of storage for multiple generations.

Digital storage, however, does have its merits including access and sorting capabilities. Online storage is becoming ever more prevalent at reasonable costs and sharing sites such as the Kodak Gallery, HP's Snapfish, or SmugMug are popular and provide storage of the full, high resolution file. However, the consumer needs to be aware that some companies sponsoring these sites have gone bankrupt and shut the sites down with little or no notice, resulting in a total loss of the stored files. A second, self-managed option for digital storage is to use multiple magnetic hard drives with redundant backup. This option requires a disciplined approach and gets complicated as the collection of images grows in size. Another, higher complexity and less desirable storage option is to routinely move images to optical media such as CDs or DVDs. One critical concern in this option, in addition to the media format, file format and data integrity concerns applicable to all digital storage as discussed above, is the media longevity. While CD and DVD optical media is available with advertised longevity of 100 years and higher, there is a large amount of anecdotal evidence that low-cost CD media lasts for two years or less. Any short-term plan by the end consumer to use optical media should center on high-quality, higher-cost media only. An additional storage option to consider are the many services today that will automatically backup files and store them "in the cloud" for a nominal service fee. As mentioned before, the long-term viability of the service provider is a potential concern here as well.

## Stability of materials used for preservation

The following section provides longevity information on various technologies used for hard copy output. For additional information on film usage in this application, where longevity estimates of 100-500 and more years are possible, see the technical papers referenced earlier. In addition, methods and a patent on film for preservation schemes are available in the literature [10-12]. A reflection medium has the advantage of being excellent for human readability but has variable longevity, which depends on the output technology chosen making careful choice by the

consumer very important. Regardless, a hardcopy print is a human-readable, technology-independent record of the digital file.

Table 1 below discusses the longevity of various reflection technologies and provides specific examples and longevity information for Kodak media [13, 14]. Longevity of similar technology materials from other manufacturers may or may not be as stable so careful comparison, using common test methods and interpretations, is called for. With one noted exception, the lifetime estimates in these tables use a new endpoint criterion that is more conservative than that typically used for consumer images [15, 16]. Because the application is for long-term storage, these predictions are based on dark keeping applications, and they include the effects of heat, humidity, and atmospheric pollutants, but they do not include effects of light.

Table 1 clearly shows there is a wide range of high quality reflection printing technologies that can be used for long-term preservation. Properly stored, hard copy prints are certainly usable for long term preservation of the consumer's "best of the best" images. The photographic industry needs to encourage people to make prints as preservation records of their images so future generations will easily be able to find and enjoy these records of people's lives without dependence on a possibly obsolete digital technology from a generation or more prior.

### The importance of metadata preservation

Metadata is, quite simply, data about data and was mentioned briefly above [17]. Virtually all digital cameras today record a wide range of metadata when an image is captured, covering simple information like the date and time the image was taken, to information about the specific camera and actual camera settings

used to capture the image. In cameras and smartphones with GPS sensors, the location of the image can be included in the metadata information package as well. From the perspective of long-term storage and preservation of consumer digital images, it is important to understand the value of metadata and the risks of losing the metadata associated with long-term preservation. From the value side, metadata replace the human "recorder" of information—the information previously written on the back of photographs, such as date and time the picture was taken. In the digital and computer world, metadata allows for rapid sorting of information by a multitude of categories. All of this information is available for user sorting and is often used in photo-album software for automated picture grouping and sorting. From the risk side, users need to be aware that this data can be lost as image files are moved in and out of certain photo editing and albuming programs (a short-term concern) or when file formats change (a concern primarily for the long term). For example, Exchangeable Image File Format (Exif), which is a specification for image file format including how and where metadata is stored, is supported by JPEG and TIFF but not by JPEG2000 file formats. Users of these types of software and file formats need to be certain that metadata remains intact. Metadata can also be lost when uploading files to on-line storage sites. At some major sites much of the high resolution image data in the uploaded file is stripped out making high quality printing difficult or impossible. In these cases it is likely the metadata would be lost as well. A quick test should be done to upload and download a file to and from the storage site to determine if the metadata as well as the original full file resolution is retained or lost.

**Table 1. Stability of reflection media for long-term storage applications.<sup>a</sup>**

Media Type	Media Name	Estimated Longevity	Comments
Thermal Dye Diffusion Transfer	<i>Kodak Professional Ektatherm XtraLife</i> media	80–100 years for 5% dye loss <sup>b</sup>	Virtually no sensitivity to humidity or ozone
Inkjet/Porous Media	<i>Kodak Ultra Premium</i> photo paper	50 to over 75 years	Using high-quality pigmented inks
Silver Halide	<i>Kodak Professional Endura</i> papers	Over 150 years	Virtually no sensitivity to humidity or ozone; greatest longevity of any silver halide paper
Electrophotographic	<i>Kodak NexPress Digital Production Color Presses</i> with Endura EP-D paper	Over 100 years <sup>c</sup>	Virtually no sensitivity to ozone; physical damage can occur in high humidity environments so storage conditions need to be carefully controlled

<sup>a</sup>Using much tighter dye loss criteria of 15%; room-temperature storage conditions of 23°C and 50% RH and pollutant-free air; lower storage temperatures can provide significantly longer longevity

<sup>b</sup>Time for 15% dye loss has not been determined due to the extremely high thermal stability; actual time will be well beyond 100 years

<sup>c</sup> Estimated based on longevity of the various components; testing on current products in progress

For those most cherished images that are printed with the purpose of long-term preservation, the benefits of recording the critical metadata information on the print itself may well outweigh the disadvantage of the effort involved. When creating photo books this is most easily accomplished by simply adding captions to the images.

### Image permanence standards

As mentioned previously, preservation requires good information on media dark stability. This is more than just thermal stability, which has been the norm for printing technologies using silver halide materials. For the newer technologies such as inkjet, standardized stability information includes gas pollutants and humidity as well. The ISO technical committee on photography (TC42) is currently working on these standards to define methods for testing and several of these standards are ready to be published. Methods for predicting life estimates are also needed, however, and these must include the four environmental factors (heat, humidity, pollutants plus light), and they need to be relevant to the specific application and end user. As mentioned in Table 1, tighter degradation criteria are needed for the application of preservation compared to normal consumer home and display predictions. The longevity estimates included here are 50% tighter (allow for half the colorant loss) than those generally in use for consumer/home longevity predictions, which can be found in the ISO Image-life parameters table of illustrative endpoint criteria contained in the silver halide stability standard [13]. These tighter criteria would yield a net change that would be considered close to a just-noticeable difference (JND). For this application of long-term preservation, that level of change is about the maximum tolerable.

### A call to action

With digital now in the mainstream for imaging, much more education is needed to make the general public/consumer aware of the risks of image loss from not having a preservation plan. The initiative that was announced in 2007 by the International Imaging Industry Association (I3A) on consumer photo preservation was a start to creating this awareness among retailers and consumers [18]. The “SaveMyMemories.org” website, also launched in 2007, received positive response initially and during its first couple of years, but needs to be further promoted to a broader audience. These efforts need support from the entire industry—this includes imaging manufacturers as well as the photo fulfillment industry. Photographers and their associated printing labs, along with online photo fulfillment sites, mass portrait and school finishing labs, have the closest connection to the end consumer and therefore have the best chance of driving this message home. Creating the awareness at the consumer level will help create the demand and stimulate the business for various high-volume photo fulfillment systems to address the consumer’s need for image preservation.

### Conclusions: path forward – reaching the consumer

This paper has described the risks associated with storage of digital data and why those risks are so high. We have also presented a solution using hard copy output to create a long-term solution that will last for multiple generations. Additionally, this paper has reviewed both traditional (silver halide), and newer (inkjet, thermal) media for storage as hardcopy prints.

Electrophotographic media, such as that used for on-line generation of photo albums, photo books, and scrapbooks is also included and is especially important given the growth in these products. A simple solution, however, does not help if the consumer is not even aware that the risks are present. Educating the consumer is the near-term issue that needs to be solved. The I3A effort was a good start in consumer education. But a broader, farther-reaching effort is needed. To make consumers aware immediately, digital camera manufacturers should take a lead role by providing educational information when a camera is sold. The photo fulfillment industry can reinforce this message to further educate the consumer while simultaneously growing revenue from photo output products. An industry consortium has been formed on photo gifts [19]. While this group is focusing on sales, providing information on the need for preservation via hard copy prints, albums and photo books could be used as a means to reinforce and further increase sales of photo products. Finally, a goal of Pixel Preservation International, in conjunction with industry sponsorship, is to reach out to the general public to educate, through examples such as those included in this paper, on the need for technology independent storage.

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## Author Biography

*Joseph LaBarca formed JEL Imaging Services in 2010 and Pixel Preservation International in early 2011, to provide consulting services to the imaging industry on image preservation, ISO standards, and image quality, after retiring from Eastman Kodak Company with over 34 years of continuous service. Joe graduated from Bucknell University in 1976 with a Bachelor's of Science Degree in Chemical Engineering and spent a large part of his career at Kodak in the research, development, and commercialization processes for Kodak Ektacolor papers and processing chemistry in both technical and leadership roles. This included extensive involvement in the stability of color papers beginning in the early 1980s and continuing for the remainder of his career at Kodak. In 1997, Joe was appointed Senior Research Lab Manager in the Imaging Media and Materials organization of the Kodak Research Laboratories, directing a laboratory with systems responsibility for professional color negative films, papers, and display materials, and held this position through June of 2004. He was then appointed Technical Director, Image Permanence in the Research Labs of the Consumer Digital Group (CDG) with responsibilities that included silver halide, inkjet, thermal dye transfer, and electrophotographic imaging systems. Joe remained in that role until his retirement. In 2008, Joe assumed the additional responsibilities of imaging systems quality for Retail Systems Solutions in CDG. Joe has been a member of the Society for Imaging Science and Technology for over 25 years and became a member of the American Institute for Conservation in 2008. In mid-2011 Joe was appointed to the position of Visiting Scholar in the College of Imaging Arts and Sciences at Rochester Institute of Technology. Joe is also a member of the ISO Technical Committee on Photography and is directly involved in the ANSI/IT-9 and ISO Working Group 5 Committees on color print stability and physical properties.*