Preservation of Documents and Photographic Images: Long Term Strategies for Future Generations

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Abstract

Upon discovering the unfamiliar 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 non-time-sequenced ("still") recordings was independent of the technology used to create them – you could hold and view a hard copy document in your hand. But even in those early days, time-sequenced recordings depended on the technology used to create them to render them back into a usable form. Our success in dealing with technology changes and rendering early recordings for the masses has been mixed at best. Hard copy documents and images, however, were never an issue until recent times. How will future generations deal with those post cards, letters to the family, and photographs that have now been replaced by "Word documents", email, and digital images on the computer? Consumers need to become aware of long-term storage and preservation issues that relate to the preservation of the data behind digital documents including photographic images, letters, etc. The more obvious issues, such as accidental or catastrophic data loss and hardware format evolution, have been recognized by the archiving community. Consumers need to be alerted to these issues and be prepared to develop preservation strategies as well. However, longer-term issues beyond routine backup and migration of data also need to be considered. The basic solution of preservation via human-readable hardcopy documents and images is one option, but this raises a fundamental question regarding image preservation that transcends even the more complex solutions—the long-term stability of the chosen media, whether digital or analog. This paper provides an update on preservation strategies for 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 awareness of the need to create a long-term preservation plan for documents and images, and the data behind them.

Introduction

As our world of documents becomes more and more digital, there is an ever-growing concern over long-term storage and the preservation of these documents, especially as it relates to the general public. The term "documents" is used in the general sense and for this paper covers all forms that consumers use to "document" their lives – photographs, post cards, letters, video recordings, etc. Many, if not most of these documents have already gone digital and the long-term implications of retrieval of these documents are the subject of this paper. Previous 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. These papers were aimed at invigorating the photo industry to create the means for technology-independent storage. The focus of this paper is threefold: 1) the need to raise the general public's awareness of long-term storage issues of digital documents of all kinds; 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 photographic and archiving industries can assist in promoting these solutions to the general public.

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, if not 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 documents; for example, it may not be until a photograph is "rediscovered" 20 to 30 years later that people may recognize how valuable it is. Similarly, genealogists have depended on these types of "rediscovered" documents to help trace family history. In the digital world, without proper attention now, these documents will simply not be available 100, 50, even 30 years from now.

Despite efforts by segments of the various industries (e.g., photography, genealogy), 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 [3-5]. 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. 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 or a letter to the family recorded on an optical or magnetic disk?

Digital adds several additional layers of complexities. Consider a 5.25-inch disk. To render a digitally stored image or document 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 will be very difficult. With a diligent effort, one can likely be found.

Interface: with the advent and proliferation of the Universal Serial Bus (USB) interface in the mid and late 1990s even if one is found, connecting a 5.25-inch drive will pose problems. 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 *defacto* 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.

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 unlikely.

Consider the discovery of a 5.25 magnetic floppy disk from 1985 containing family genealogical 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 Office products, 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. Even standardized and widespread file formats change. File format is a very serious concern for long-term preservation.

This example also illustrates the importance of labeling. With the advent of 3.5-inch "floppy" disks, the jacket was no longer needed and labeling of the contents pretty much ended. Thus discoveries of these and later generation disks, including optical media and beyond, resulted in little or no labeling along with a much higher number of files per disk, making the task of document discovery or location all the more difficult.

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 or genealogist finding digital family information after two or three generations. It is safe to assume that the consumer would never even attempt a restoration and the family history would essentially be lost.

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 burners down. Then the same thing happened with DVD burners. 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 microdrives and 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. By its very nature, "technology" always advances. 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. As mentioned above, Microsoft has replaced their long-standing DOC, XLS and PPT formats with new ones that are not backwards compatible. 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, but has not yet shown signs of replacing JPEG. 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 20 years' time?

Historical perspectives

Many studies are available on the long-term storage of digital information [6]. 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. A benefit of these systems is accessibility—the data is searchable and can be quickly retrieved. However, the cost of this accessibility is the dependence upon the computer and its associated storage devices, which continue to evolve, thus requiring an ongoing migration plan. An example of such a system is the on-line photo servers where storage is essentially free. 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 [7].

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 picture 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 [8].

Preservation of photographs in the home has historically centered on hard copy prints in albums, scrapbooks, and shoeboxes. For documents, the original hard copy of letters, post cards, etc., has served us well over time. In photography, there has been significant growth in digitally generated scrapbooks and photo albums in the last couple of years and growth of these products is expected to continue. Negatives, which are a somewhat compressed and more efficient storage format, are often times unorganized or simply not available. This also applies to slides/transparencies. While a hard copy print provides no compression of the information, and as such, tends to take up a large volume, it is human readable and therefore requires no system architecture to be put into use. Negatives and transparencies, on the other hand, do require some level of supporting system to use optimally, but they are human readable, none-the-less. They also provide for some compression of the data (4.2 times in 35 mm format, for example). Longevity of 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 the consumer 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 through hard drive crashes, media decay, data corruption, and the various format changes. Even if there is some level of organization, consumers tends not to think about what will happen in both the shorter term, when they need to replace their computer, or the longer-term impact of file format and media format changes. All of these impacts result in the need for continual long-term migration of an ever-growing digital image collection.

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-dependant changes. Key requirements of a good archiving system include low maintenance, cost-effective retrieval (based on the need for immediate or less-than-immediate access), as well as high storage density, longevity, and cost-effective life-cycle costs. What is an acceptable life cycle? The answer depends upon risk and balancing factors of hardware and media longevity. If one looks at 5.25- and 3.5-inch magnetic floppy disks, one could conclude a migration cycle of 20 to 25 years provides an acceptable risk, with note that the availability of new personal computers with 3.5-inch drives has disappeared over the last several years. However, looking at the more rapid evolution of optical media, one could conclude the cycle time is well under 20 years. Being conservative on the risk from all sources (hardware and media format, computer interface, file format, data integrity), a 15 to 20 year migration cycle is very likely too long and even half that time could be a problem. Depending upon the media selection and how mature the system, using a five- to-ten-year cycle is a better balance. A total rewrite of one's database every five to ten years is a huge amount of work, especially when considering how quickly the volume of information grows. Total rewrite is a short-term consideration. One also must consider that consumers want at least some information 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

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

A film-based system for technology independent storage of images and documents was discussed in previous papers [1, 2], but an operational industry infrastructure to accomplish this is still lacking. Despite this, options exist today for the consumers to store their images for the longer term. The first and simplest way is to make hardcopy prints of the most valuable images and documents. For images, 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 Goolge® search on "professional photographic printing" provides many sources of high quality printing. With all of the long terms concerns that have already been discussed, printing of the consumer's "best of the best" images and documents is the simplest and most reliable means of storage for multiple generations.

Digital storage, however, does have its merits. These include access and sorting capabilities, but require careful management of the metadata that was produced when the image or document file was produced, and a logical file/folder naming architecture. Online storage for documents of all kinds is becoming ever more prevalent at reasonable costs. For images the sharing sites such as the Kodak Gallery, HP's Snapfish, or SmugMug are popular. These services make use of digital storage devices and servers to provide ready access to images; concerns about physical format changes of the storage devices and servers are the responsibility of the service provider and should not be a concern of the end consumer, although file format changes are not addressed. In many cases, this storage is available for free if a minimum annual quantity of printing is done. However, the consumer needs to be aware that 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. Making use of redundant drives is critical, recognizing the mechanical limitations and wear impact of rapidly rotating disk drives. New, high capacity hard drives based on flash memory can also be used although the newness of this storage medium means there is little actual data to compare to the proven reliability of mechanical hard drives. Current data suggests that repeated access of flash memory will over time result in data loss; archival suitability with limited access is unknown. 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.

Stability of materials used for preservation

Table 1 outlines reflection and transmission media for use in preservation and provides information on their advantages and disadvantages. Even though there is not an easy means for consumer storage on to film, the information is provided to highlight the benefit of film as a technology-independent, multi-generational storage medium. For additional information on film usage in this application, see the technical papers referenced earlier. In addition, methods and a patent on film for preservation schemes are available in the literature [9-11] A reflection medium has the advantage of being excellent for human readability. However, it is poor for storage density (albums fill up fast) and has variable longevity, which depends on the output technology chosen making careful choice by the consumer very important. Nonetheless, a hardcopy print is a human-readable, technology-independent record of the digital file. Transmission media has variable unaided human readability, depending on image compression, which is a direct tradeoff to storage density. Depending on film type, the media has good to excellent storage longevity.

Table 1. Characteristics of reflection and transmission media for preservation.

Media Type	Human Readability	Storage Density	Longevity
Reflection	Excellent	Poor	Excellent to Poor
Transmission	Poor to Excellent	Excellent to Poor	Good to Excellent

Tables 2 and 3 discuss the longevity of various reflection and transmission technologies, respectively, and provide specific examples and longevity information for Kodak media [12, 13]. 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 [14, 15]. 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.

As is evident in Table 3, there are significant longevity benefits for silver halide film, and we are hopeful a business model in the photographic industry will emerge that supports film for use in long-term preservation that is independent of current and future digital technologies. Table 2 clearly shows there is a wide range of high quality reflection printing technologies that can be used for long-term preservation. Despite a reflection print's low storage density, hard copy prints are certainly usable for 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.

Table 2. Stability of reflection media for long-term storage applications.[a]

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

[a]Using much tighter dye loss criteria of 15%; room-temperature storage conditions of 23ºC and 50% RH and pollutant-free air; lower storage temperatures can provide significantly longer longevity

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

[c] Estimated based on longevity of the various components; testing on current products in progress

Table 3. Stability of transmission media for long-term storage applications.[a]

Media Type	Media Name	Estimated Longevity	Comments
Silver halide color reversal film	*Kodak Ektachrome* films (E-Series)	Over 100 years	*Kodak Ektachrome* duplicating film has the highest image structure, lowest ISO speed of the *Ektachrome* family
Silver halide color reversal film	*Kodachrome* films[b]	Over 120 years	Similar benefits to *Kodak Ektachrome* films; limited processing availability
Silver halide color negative film	*Kodak Vision* color intermediate film (motion picture)	Over 100 years	Image structure comparable to *Kodachrome* film; limited processing
Silver halide color negative film	*Kodak Professional Portra* films	Over 50 years	Image structure slightly reduced vs. *Kodachrome*, but high ISO speeds; processing widely available
Silver halide B&W negative film	*Kodak* black and white films	Over 500 years[c]	Silver image as opposed to dye; includes motion picture, micro-, and camera films

[a]Using much tighter dye loss criteria of 15%, room-temperature storage conditions of 23ºC, 50% RH, and pollutant-free air, lower storage temperatures can provide significantly longer longevity
[b]*Kodachrome* is no longer available but is included as a comparison to *Kodak Ektachrome* film given its performance and reputation for longevity in dark storage applications
[c]When used with polyester-based films.

The importance of metadata preservation

Metadata is, quite simply, data about data and was mentioned briefly above [16]. 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 with GPS sensors, the location of the image can be included in the metadata information package as well. For documents, metadata may include the author's name, creation date, modification/update date, comments, key words, and many other attributes.

From the perspective of long-term storage and preservation of consumer digital images and documents, 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. Examples of the more commonly used categories include file size and type, date modified, author, and title; and specifically for images, date picture was taken, and camera model. Less common photographic attributes include picture dimensions, owner, and copyright information. On higher-end digital cameras, specific information such as exposure and ISO settings, lens focal length, exposure and flash compensation, color space, and white balance, and possibly GPS location information are available as well. 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 corrupted or lost when making successive copies of the digital images during routine migration. The 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.

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.

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. 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, 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 [12]. 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

Much work is being done in academia and in large institutions on the preservation of digital information and images. Concerns around long-term preservation have been recognized in these applications. With digital now in the mainstream for documents, email and imaging, much more education is needed to make the general public/consumer aware of the risks of document and 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 [17]. 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 museums and libraries—essentially any institution dealing with images and documents. Support from genealogical and scrap booking organizations would provide a reinforcement of these messages regarding the importance of passing information on to future generations without being tied to a particular technology or infrastructure that may, and likely will, become obsolete given enough time. Creating the awareness at the consumer level will help create the demand and stimulate the business for various high-volume systems to address the consumer's need for image preservation, including human readable, hybrid, and all-digital systems.

All will play a large role in digital preservation depending upon accessibility needs and cost constraints. The imaging industry, through I3A, has begun the education effort, but a broader perspective of the digital industry needs to work together to deliver and reinforce the long-term preservation message to the general public.

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 simple 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, and to a minor extent, film. 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. An industry consortium has been formed on photo gifts [18]. 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. The recently formed Memories Preservation Council has consumer awareness and education as its goal. This group strongly needs the support of the photo industry to succeed in its mission. 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. 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.