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Digital Media in Art: Meaning, Materiality, Digital Forensics Workflows, and Conservation

ABSTRACT

Decision-making in time-based media art conservation is guided by a thorough understanding of the identity of the artwork – what qualities or physical elements can be changed or replaced as the work ages, and which cannot. The shared education in conservation methodology across specializations can be brought to bear on the process of acquiring this understanding, which enables the conservator to determine the meaning and significance of the digital media in the artwork. Conservators must also ensure that the physical elements of the work are preserved. These may include diverse display equipment, magnetic or optical media, digital files and more. Together, these efforts form the basis for ethical conservation treatment. This paper highlights two examples: preservation planning for a work by Jennifer McCoy and Kevin McCoy titled *Every Shot, Every Episode* (2001) in the collection of The Metropolitan Museum of Art in New York, and the archiving of Jeremy Blake's born-digital production files in Fales Library & Special Collections at Elmer Holmes Bobst Library at New York University. Bobst Library is one of the few cultural heritage institutions in the United States to have a forensic workstation at a time when digital forensics workflows are becoming the recommended practice for managing born-digital materials in archives.

1. INTRODUCTION

In collecting media art, what does an institution actually acquire? According to the *Matters in Media Art* project (an initiative of several museums to develop effective strategies for caring for time-based media art) the answer is, "a combination of content, hardware, instructions, and rights" (FAQ, *Matters in Media Art*). First, *content*: digital and analog data on a variety of carriers, including videotape, film, discs, and hard drives. Second, *hardware*: such as playback equipment, projectors, monitors, and speakers. Third, *instructions*: including assembly, room dimensions, placement of equipment, model and manufacturer information for artist-preferred equipment, projector settings, light levels, sound levels, and so on. And finally, *rights*: such as authorization to duplicate and migrate content for preservation purposes, and to present the work under certain conditions. Collecting this type of artwork challenges established practices in acquisition, registration, exhibition, and conservation. This paper is intended to give a sense of the challenges that media conservators face while working to preserve artworks that have digital elements. After a brief discussion of theory and decision-making in media art conservation, the preservation issues presented by one particular work of art will be described in detail. This work of art contains, as a sculptural component, one specific type of digital data carrier – the video CD. In this case, the video CDs are not only the carriers of the content, but they are an integral part of the meaning of the work. Finally, this paper will describe how digital forensics workflows can help save digital data on obsolete carriers, including video CDs.

2. WORK-DETERMINATIVE PROPERTIES

Pip Laurenson is a pioneering conservator of time-based media art at Tate. She recognized that the conservation treatment of media art required a new approach, and that it could not depend on the maintenance of a single, material "original" work of art. She realized that media artworks often have an identity that can be maintained even if some material elements are changed or replaced as the work ages. She found a possible theoretical model in music philosophy, in the work of Stephen Davies. Davies said of the tradition of Western music that "a performance of a given work is authentic if it faithfully instances the work, which is done by following the composer's work-determinative instructions as these are publicly recorded in its score" (Laurenson 2006). Laurenson (2006) proposed that those elements of an artwork that cannot be changed without compromising the integrity of the work *as art* should be called the "work-determinative" properties. She suggested the adoption of a score/performance model for time-based media art conservation, where the "work-determinative" properties of an artwork would be like the musical score, and become the core structure around which the remainder of the decisions would be made. Hers is not the only theory, but all seek in some way to replace the notion of conserving a singular, material art object with preserving the identity of an artwork, allowing for some acceptable change over time where ethically possible.

To transform the various media elements, playback equipment, and instructions from the artist into the presentation of the work *as art*, the museum or custodian must understand the "work-determinative" properties. To achieve this, information is gathered not just at acquisition, but over time. The artist's attitude toward the various elements of the work may only become clear after a number of artist-approved installations in different settings (Phillips 2012). It may be that an artwork is ultimately not media-dependent, making it possible for conservators to substitute new technology for old in order to perpetuate the artwork. However, some works have aging media or equipment that is essential to the meaning of the work, and cannot be changed. To make these determinations, media conservators draw upon their traditional training in treatment methodology. Conservators across specializations are trained to analyze all aspects of the artwork—material and immaterial—prior to intervention, and media art is no exception.

In cases where the work-determinative properties *are* media-dependent, museums may need to keep obsolete technology alive in order to continue to exhibit the work. One example is *Oratorium for Prepared Video Player and Eight Monitors* by Frank Theys (1989), in which a videotape is played with an artist-modified video player that sends the tape out of the player and around the room during playback. The artist said it would contradict the meaning of the work to simulate its functioning with new technology (Lorrain 2013, 60). Once the monitors, videotape, or player are beyond repair, this work can no longer be exhibited, and it will only be incompletely experienced through documentation (Lorrain 2013, 66).

3. MATERIALITY AND DIGITAL DATA

Time-based media art often relies on mass-produced magnetic, optical, and solid-state storage devices (such as hard drives, video tape and discs, and flash drives) to carry the electronic signals and data that constitute the artwork. Sometimes these are integral to the meaning of the work, and sometimes not. But they are just as material as a painting or sculpture. The encoded data is physical, often even durable, and can be copied by electronic means, despite the fact that its essential materiality cannot be observed at human scale.

While evanescent text and images on glowing screens may seem immaterial, it is well known in the computer forensics field that magnetic and optical media are indeed quite material, and that machine writing to these storage media is always unique at the micron scale (Kirschenbaum 2008, 63). In his book *Mechanisms: New Media and the Forensic Imagination*, Matthew Kirschenbaum points out that, even when subjected to extreme physical trauma (even being submerged, burned, or crushed), computer hard drives can retain the information inscribed on them. This information is in the form of "patterns of magnetic flux reversals, a number of which may be necessary to constitute a single bit" (Kirschenbaum 2008, 60-61). In another phenomenon known as data remanence, these patterns may be recovered even after deliberate deletion and overwriting. This is due to "misregistrations" in writing to the magnetic hard disk that create "a classic palimpsest effect" (Kirschenbaum 2008, 64).

For the widespread misperception that machine inscription on computer storage media is somehow fleeting and ephemeral, Kirschenbaum blames the graphical user interface and decries the resulting "screen essentialism," which emphasizes user experience at the expense of technical and physical reality (Kirschenbaum 2008, 34). Media conservators must understand the unique material qualities of data and storage media, the methods of their manufacture, and their preservation requirements. Moreover, they must understand how, and how much, these media matter in the authentic iteration of the artwork. As the following case study will show, the data storage media can be as much a part of the work as the digital information. As part of an artwork, optical media (such as CDs) can function as an aesthetic, kinetic, and interactive element.

4. CASE STUDY: AN ARTWORK WITH 278 VIDEO CDs

Even if an artist has indicated that the technology within a work can be changed, works that incorporate digital media present issues that are difficult to resolve. One example is the work *Every Shot, Every Episode* (2001) by Jennifer McCoy and Kevin McCoy, in the collection of The Metropolitan Museum of Art in New York. It contains a portable video CD player with speakers and LCD screen (fig. 1). Several shelves of video CDs are mounted alongside it (fig. 2).

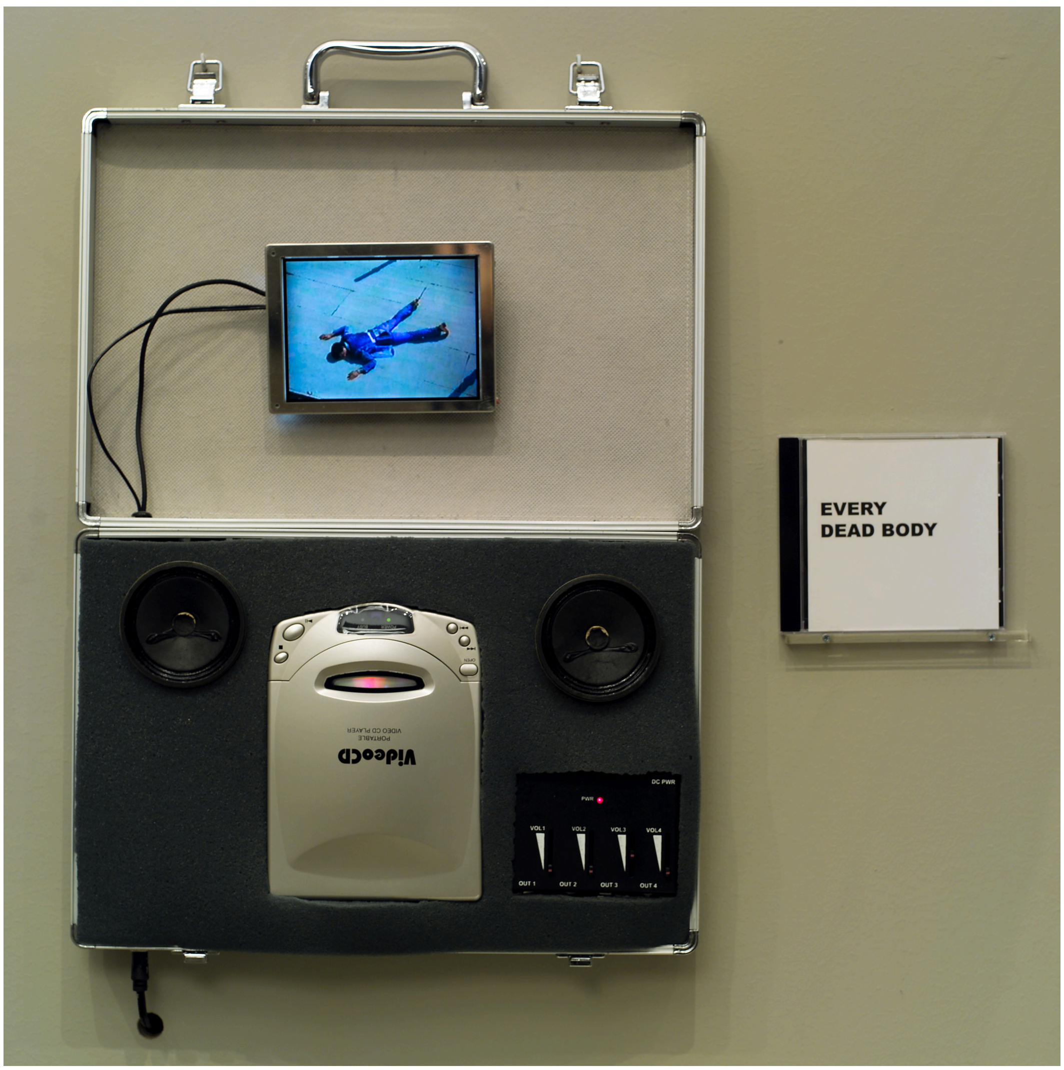

Fig. 1. Jennifer McCoy and Kevin McCoy, *Every Shot, Every Episode*, 2001, detail, video (variable media), 40.6 x 50.8 x 5.1 cm (16 x 20 x 2 in.), The Metropolitan Museum of Art, New York, from www.metmuseum.org © Jennifer and Kevin McCoy

Fig. 2. Jennifer McCoy and Kevin McCoy, *Every Shot, Every Episode*, 2001, installation view, video (variable media), 40.6 x 50.8 x 5.1 cm (16 x 20 x 2 in.), The Metropolitan Museum of Art, New York, from www.metmuseum.org © Jennifer and Kevin McCoy

The artists' website (http://www.mccoyspace.com/project/51/) describes the work as follows:

> The source material for this work is a collection of 10,000 shots from [the television series] *Starsky & Hutch*. Each episode is broken down into a series of individual shots. The artists have assigned key words to each shot: every plaid, every sexy outfit, every yellow Volkswagen, etc. There are 278 categories in total. Each category is archived on an individual video CD which is labeled in clear, bold lettering and installed in the gallery on a shelf. Video CDs are chosen by the gallery visitor and played via the built-in video screen.

Hardware obsolescence is a major conservation concern with this work. However, the focus of this paper is the digital media—the video files stored on the CDs, which are a very different carrier from the magnetic hard drive Kirschenbaum described. The video CD format is nearing obsolescence, and the artists are enthusiastic about supporting the museum's efforts to conserve this work. Following a 2013 summer internship working with the variable media collection in the Department of Photographs at The Metropolitan Museum of Art, the author visited Kevin McCoy at the artists' studio in May 2014 on behalf of the museum to perform an inventory of material related to the work so that the museum could identify what it needed for conservation and preservation efforts.

The first step was to understand how the videos were made. McCoy explained that the source material was the Columbia House video club set of VHS tapes of the *Starsky & Hutch* series. The artists digitized the tapes and used Macromedia Director to designate the in/out points for each clip. They wrote AppleScripts to extract the selected clips from each full-length episode. Using FileMaker Pro, they assigned category names to each clip, and exported the filenames associated with each category. The artists then wrote a script to shuffle the filenames. Finally, the clips were burned in the shuffled order onto each category CD. In preparation for burning onto video CDs using the application Roxio Toast, the files were converted to MPEG_TR, the "Toast Ready" file format, and the video format was MPEG-1.

The video CDs themselves have a complex material nature. They have a layered structure comprised of polycarbonate, metal, and other materials. All optical discs (whose data is "read" by a laser) contain data stored in a spiral, somewhat like a vintage vinyl record. However, the data is in an interior layer, instead of a surface groove. The data is numerically encoded and physically stored to the surface in a tiny but machine-readable pattern of what are called "pits" and "lands." Discs authored by a manufacturer have an actual relief pattern pressed into the data layer. This changing topography is what is "read" by the laser. In the case of recordable discs (CD-R, DVD-R), the disc contains a photosensitive organic dye layer, so that data can be "written" to the disc with the laser in a personal computer. Data is encoded when the computer's laser is in "write" mode and selectively "burns" the dye in the pit-and-land pattern. The resulting pattern is more irregular than a manufacturer's molded pattern, and less stable. The laser "reads" this pattern by detecting whether or not the light reflects off of the metal layer of the disk back to the sensor. Re-writable discs have a phase-changing metal alloy instead of a dye layer. Different types of discs have slightly different layer structures and materials (Byers 2003, 5-12). As such, different types of discs have different relative stability.

Generally speaking, data stored on writable optical disc is more vulnerable to loss than that stored on a magnetic hard drive. One reason is the instability of the organic dye. *Every Shot, Every Episode* has 278 discs of this type.

When asked about how to address the appearance of the video as the work aged, McCoy responded that the aesthetic quality of the video should always approximate the quality of the original piece ca. 2001. It should look like digitized VHS video played back on the original LCD. Maintaining the appearance of the video requires an understanding of the aspect ratios and resolutions of the video files and LCD, and how to preserve these in tandem. Incidentally, the audio quality and the speakers in the piece present a similar challenge. McCoy was comfortable with the slight distortion of the video clips due to the difference in aspect ratio between the clips (4:3) and the original LCD (16:9). As display resolutions increase in the available replacement screens, the video quality will appear to degrade. As such, if, at some point in the future, the video cannot be played back at its original quality due to the changes in screen technology, the artist suggested that the museum may wish to re-master the video by duplicating the selection of clips in each category from a high-resolution copy of the *Starsky & Hutch* series. At that point, the production files in the artists' archive could prove useful.

Considering the imminent obsolescence of the video CD player, McCoy was supportive of copying the video files off of the video CDs and instead running the files off of a hard drive. However, he felt that a small motor should be installed in the defunct video CD player to spin the disc. This way, this important kinetic element in the piece would be maintained, but the failure of the video CD player could be overcome. He also felt that the jewel case on the small shelf indicating the CD currently playing would still have to be properly positioned. The "now playing" position of the jewel case is one of the "work-determinative" properties according to the artist, as is the spinning disc, while direct playback from the video CD itself is not.

The description of the work on the artists' website suggests that the gallery visitor's ability to interact with the piece is a work-determinative property. Indeed, in an interview with Kevin McCoy, curators, collection managers and students at The Metropolitan Museum of Art in March 2014, the artist stated that interactivity was essential (McCoy et al. 2014, 29-30, 50:26:02). However, the museum was unable to allow direct visitor interaction with the piece, given the fragility of its media and legacy display equipment. The artist understood this, but wondered if there might not be a better solution than displaying the CDs inside a Plexiglas box (McCoy et al. 2014, 29-30, 01:00:38:13). When asked about the importance of interactivity, he replied:

> What are we going to do to make it robust enough for the masses of people that come to the Met? I don't know, that seems really hard, without completely virtualizing the piece or doing some other kind of thing that I think is the wrong way to go. I mean, turning it into a touchscreen thing just makes it irrelevant… (McCoy et al. 2014, 24-25, 50:50:22).

His statements on interactivity suggest that, while it is indeed a work-determinative property, he feels he must accept that the piece, practically speaking, cannot be interactive in all contexts. However, a media conservator reexamining the work-determinative properties and identity of the work may arrive at new solutions, despite the limitations. Perhaps, for most of an exhibition, the work is displayed with video running as selected by museum staff, to be appreciated aesthetically and conceptually. But a lottery or sign-up process could be used to identify a few people who can interact with the work in the intended way.[1] Other museum-goers could observe while these individuals play their role in making the iteration authentic, at least until the last video CD player finally fails irreparably, or until the technology is no longer familiar, altering the very meaning of the interactivity.

In this case, direct communication with one of the artists regarding his attitudes toward the aging of the work provided valuable guidance for preservation planning. Through the interview process, some of the work-determinative properties came to light, as did a fuller understanding of the identity of this artwork. Now knowing that operation of the original digital storage medium itself is not a work-determinative property according to the artists, the door opens to new preservation possibilities. Presently, the only copy of the video is stored on the CDs. The museum could not allow a visitor to handle those, but perhaps exhibition copies could be created for that purpose. The files could also be copied and the back-ups stored in a digital repository. But, generally speaking, how should digital files on legacy carriers be copied? The answer today is to turn to digital forensics workflows.

5. CASE STUDY: DIGITAL FORENSICS AND AN ARTIST'S ARCHIVE

Digital forensics provides the tools needed to examine and copy data without altering it. Copying a file from media such as CDs, floppy disks, or hard drives can result in minute alterations in the file. For example, the "Date Modified" information in the file may change to today's date. This not only represents an alteration of original material – the bits of data – but also could cause confusion in the digital repository down the line. Digital forensics offers the techniques and workflows needed to ensure that copying bits from one carrier to another is done accurately and preserves the original bitstream.

In recent years, the cultural heritage community has adapted some of the digital forensics techniques used in the law enforcement and security fields for processing and analyzing born-digital materials. According to Kirschenbaum, computer forensics is defined as "the activity of recovering or retrieving electronic data, analyzing and interpreting it for its evidentiary value, and preserving the integrity of the data such that it is (potentially) admissible in a legal setting" (Kirschenbaum 2008, 46). Around the year 2000, libraries with electronic media collections became concerned about how to maintain legacy playback equipment, handle and store the physical data carriers, and recover data from damaged and obsolete media (Ross and Gow 1999). Within the decade, significant initiatives were underway to combine learning from the digital preservation sector with that from the field of digital forensics, and apply that to the preservation of born-digital materials in collections.[2] The adoption of digital forensics for cultural heritage is still in its relatively early stages. The recent addition in 2014 of a digital forensics workflow for born-digital collections at Elmer Holmes Bobst Library at New York University is a cutting-edge development. NYU remains one of the few institutions in the United States to have taken this important step.

In the fall of 2014, during an independent study in the Digital Library Technology Services department at Bobst Library, the author imaged nearly all of artist Jeremy Blake's production files stored on optical discs and Zip disks. (Disk imaging in this context means making a bitstream copy of the disc's contents). Blake earned a BFA from the School of the Art Institute of Chicago in 1993 and an MFA from California Institute of the Arts in 1995. After years of painting in traditional media, he developed what he called "time-based painting"—born-digital works created with scanned imagery, digital photography and Photoshop tools, subsequently animated in the software program After Effects in collaboration with a graphic artist, then edited in Avid, and exported to DVD (Madoff 2005). The *New York Times* said of these works, "They are an utterly 21st-century art form, a hallucinatory bitstream of data" (Madoff 2005). These were displayed as video projections that alternate between narrative and abstraction—pattern, color field, and image. His work appeared in three consecutive Whitney Biennials in 2000, 2002, and 2004. His commercial work included the opening credits for the feature film *Punch Drunk Love*, and videos and album art for Beck. Curator Benjamin Weil who organized the exhibition of Blake's work "The Winchester Trilogy" at the San Francisco Museum of Modern Art stated, "Jeremy's early work was so seductive that while it was praised, some thought it was maybe too beautiful, too nice. But the newer works are more relentless, more layered and disturbing. They seduce you with that beauty and then turn to their real subjects: violence, power and fear" (Madoff 2005).

Following his tragic death in 2007, Blake's archives were transferred to Fales Library & Special Collections at Bobst Library. The Blake archive at Fales is a combination of paper and electronic records. The digital material arrived on a variety of carriers. Over 300 CD-Rs, DVD-Rs, and Zip disks were imaged. The way in which the discs were imaged has implications for how the data on the discs in *Every Shot, Every Episode* should ideally be copied and archived.

Digital forensics workflows need not automatically require a large investment; for some collections, one portable write-blocker[3] and a computer on hand may suffice. However, in the case of a collection with a diversity of new and older media, it is necessary to invest in a powerful PC workstation, versatile write-blocking software or hardware, and a range of legacy disk drives. Disk imaging software and a digital repository for archiving the disk images are also required.

Handling the CDs and Zip disks such as those in the Blake archive can be done with a straightforward workflow. First, a database of some kind is required to catalog information about the physical media: accession number, type of media, labeling, physical location, and so on. The physical media is also photographed. For the forensic disk imaging step, the format of the disk image can vary. Some image formats contain metadata about the disk image itself, while others are simply clones of the disk contents, and the former is better for archival purposes. Free disk imaging software is available online that creates a range of image formats. Choosing a disk image file format depends on the media being imaged.

There is a lot of other information in a digital file besides the user-created content. This is called *metadata* and it is invisible to the casual user. It can be technical, descriptive, or administrative, or it can be related to file preservation or use (Gilliland 2008). Other hidden data may also be stored on the carrier. In the case of hard drives, "deleted" data may still be there. A *forensic disk image* can copy everything – even fragments of working files and deleted files. A *physical* disk image is a complete copy of the contents of the storage media. The resulting bitstream copy is essentially a clone. This could reveal some interesting file fragments on a Zip disk or hard drive that had been in continuous use, for example. A *logical* disk image is an image of a set of files, not a complete copy. This is the type of imaging often done with optical media—it does not include unallocated space, nor does it include deleted files, which write-once optical media obviously do not have. At Bobst Library, ISO was the format of choice for the logical images in the Blake archive.

Once the forensic disk image is created, it is simply a file, or series of files. Hashes or checksums (like fingerprints for digital files) are verified and entered into the database to ensure a successful copy. At this point, some institutions take additional steps. The BitCurator tools are free, open-source, and tailored to the needs of cultural heritage rather than law enforcement, and these allow some key actions to be performed on the disk images before they are moved to a digital repository (Woods and Lee 2012). These tools can generate file lists, extract technical metadata for easier reference, and locate private or personal information for redaction. So, the disk image is just one step in the process. Creating them is not difficult, but managing them—preserving them sustainably and making the contents discoverable and useful—is a different story.

For appraisal, arrangement, and description of digital archives, there are software programs that enable the user to list deleted files and explore them with hex editors, see thumbnails of image files, create timelines based on date information in files, and organize files by type, which can help with planning for file format support in the digital repository. Forensic Toolkit (FTK) is more robust than the BitCurator tools, but proprietary and comparatively expensive. It will preview many file formats, which can help in the appraisal phase. Forensic Toolkit is the software used at Bobst Library, and it was important for previewing Jeremy Blake's production files, many of which were layered Photoshop files. Providing bitstream support—stopping at merely saving a disk image—does not ensure access to that material over the long term. It may be necessary to maintain legacy equipment or use emulators to actually launch the files that have been copied, to see what the artist saw.

6. CONCLUSION

Digital media in art requires evaluation by a conservator, as well as special care and maintenance. In the case of *Every Shot, Every Episode*, after establishing that playing the video directly off the original video CDs was not a work-determinative property according to the artist, you would investigate alternatives, such as playing the digital files off of a hard drive. Assessing the risks to the work, you would now know, and be concerned, that the video CDs were burned in the artists' studio, and that those dyes degrade over time, among other vulnerabilities. You would know that holding only one copy of the digital data is not ideal, but before making a copy you would now know to consider whether or not you first need write-blocking hardware or software in place. You would also know that adopting a digital forensic approach would enable you to avoid altering the original bits during the course of copying the files for preservation purposes. Finally, you would provide for the long-term storage of the properly housed original discs in a correct environment, ideally 18ºC, 40% RH (Byers 2003, vi), while providing for long-term storage of the digital files in a trusted digital repository that meets or exceeds minimum standards for digital preservation (Dale and Ambacher 2007). In the case of artists like Jennifer McCoy, Kevin McCoy, and Jeremy Blake, whose artworks contain digital components or are entirely born-digital, preventive conservation takes on new meaning, and a thorough understanding of conservation ethics and methodology, digital forensics, and digital preservation standards is essential.

ACKNOWLEDGMENTS

The author would like to thank the Department of Photographs at The Metropolitan Museum of Art for hosting her summer 2013 internship working with the variable media collection; the Andrew W. Mellon Foundation for its generous support; and the faculty and staff of the Conservation Center. She is particularly indebted to the following people, without whom her advanced study in media art conservation would not have been possible: Christine Frohnert, Conservator of Contemporary Art, Bek & Frohnert LLC; Adjunct Professor in Conservation, New York University (NYU); Glenn Wharton, Conservator and Clinical Associate Professor, NYU; Ben Fino-Radin, Digital Repository Manager, Museum of Modern Art, NY and Adjunct Professor, NYU; Kate Lewis, Media Conservator, Museum of Modern Art, NY; Donald Mennerich and Julia Kim, Digital Archivists, Digital Library Technology Services (DLTS), Elmer Holmes Bobst Library, NYU; and Joanna Phillips, Time-Based Media Conservator, Solomon R. Guggenheim Museum, NY.

NOTES

1. Similarly, during the *Stieglitz, Steichen, Strand* photography exhibition at The Metropolitan Museum of Art (November 10, 2010 – April 10, 2011) five original autochromes were exhibited from only January 25 to 30 due to their extreme light sensitivity. For the remainder of the exhibition, facsimiles were shown in their place.

2. These developments are described in the paper that effectively introduced digital forensics to the cultural heritage sector, marking the convergence of several fields: digital forensics, archiving, and digital preservation. M. Kirschenbaum, R. Ovenden, and G. Redwine. 2010. *Digital Forensics and Born-Digital Content in Cultural Heritage Collections*. Washington: D.C.: Council on Library and Information Sources. http://www.clir.org/pubs/abstract/reports/pub149 (accessed 06/27/15)

3. Write-blockers prevent users from inadvertently altering the data on digital storage devices.

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