The Solid-State of Things: Small-Scale Archival Workflows
Introduction to MIAP
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The world of video production is currently undergoing a major technological shift. Small and mid-sized production companies and independent producers, many of whom moved from recording on film to recording on digital video tape around the late 1990s, are making another transition – this time to recording on solid-state or file-based technologies. The primary technology that is being used is Panasonic's P2 (or Professional Plug-in) system, introduced in 2004, although other technologies exist, such as Sony's XDCAM EX system. These solid-state systems offer a variety of advantages in terms of production cost and speed, but they are requiring users to completely rethink how they approach the archiving of their material. While many producers have become used to an archival system of storing tapes on shelves or in boxes, P2 and other solid-state recorded material requires an entirely new archival paradigm.

This paper will attempt to provide an assessment of the current state of solid-state recording and archiving, as seen through a series of case studies of production companies who have been using P2. These issues will be covered through the perspective of the producers who are trying to figure out how to best save their own material, and also with an eye towards the archival professional who may find herself, many years down the road, having to examine, save, or restore this work. Through these findings, and through the examination of the workflows at a larger organization which has also made the shift to P2, this paper will attempt to suggest some recommendations and "best practices" related to P2 archival strategies that will hopefully prove useful for producers and archivists. It is important to note that this paper deals primarily with archival strategies for raw footage and other associated files (project files, graphics, stills), rather than finished products[1].

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[1] For more information on archival strategies for file-based finished products, see the NYU Preserving Digital Preservation Program (mentioned later in this paper) or the NYU/Merce Cunningham Dance Group "Mondays with Merce" project.

Technology Background

P2 was created as a complete production system which records media onto removable memory cards. The most commonly used camera is the AG-HVX200 (colloquially referred to simply as the "200"), which was released in late 2005. It featured the ability to record onto either MiniDV tapes, using the DV codec, or onto P2 memory cards, for which it included two slots, using DV, DVCPRO, DVCPRO50 or DVCPRO HD codecs. At the time of release, it was the only small-format (i.e. not shoulder-mounted) camera to feature these recording formats, making it attractive to independent videomakers and small production companies. The use of the DVCPRO HD codec was a particular draw, as it features 4:2:2 chroma sampling and the ability to record at either 720 or 1080 lines of resolution. Retailing at $6000, the 200 offered an affordable HD option for producers, either to use as a primary camera or to intercut with DVCPRO HD footage being shot on larger cameras, such as the Panasonic Varicam or the AJ-HDX900.[2] Panasonic would later release a variety of other P2 cameras, including the AJ-HPX500, a shoulder-mounted camera with four P2 slots, and the AJ-HPX170, a version of the 200 without the ability to record onto tape. Notably, most of the newest models, such as the AJ-HPX2000, allow for recording with Panasonic's newer AVC-Intra codec, which is based on the H.264 standard and allows for higher bit rates and greater encoding efficiency.

The P2 cards are PCMCIA memory cards, which currently come in sizes of 4, 8, 16, 32 or 64 GB. Footage shot with the DVCPRO HD codec takes up 1GB per minute – severely limiting total recording time with the smaller-size cards – however, the cameras' multiple slots and ability to swap cards in and out while recording means that it is technically possible to record continuously for an unlimited amount of time. Data can be copied from P2 cards to computers either directly, by inserting the card into a laptop with a compatible slot or with an product such as the Duel Adaptor, or indirectly, through a device such as the AG-PCS060G, a 60GB hard drive with one card slot, or the AJ-

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[2] Sony's HDV format, based on the MPEG2 standard, already existed and was cheaper, but with its 4:2:0 subsampling and inter-frame compression, it was generally less attractive to professionals.

PCD20, a five-slot card reader. Panasonic has also released the FS-100 (aka FireStore), a 100GB hard drive which attaches to a camera, bypassing the need for P2 cards.

No matter which codec is being used, the footage is recorded to the cards in an MXF (Material Exchange Format) wrapper and saved in a series of six folders. Two of these (VIDEO and AUDIO) contain the video and audio streams, saved separately, in MXF format, the ICON folder contains bitmap thumbnails, the CLIP folder contains an XML metadata file, and the generally-unused VOICE and PROXY folders contain a voice memo Wave file and an MP4 proxy video file, respectively. These folders are all contained in a folder entitled CONTENTS, and a file titled Lastclip.txt, which is located outside this folder, lists the name of the last clip contained on that card. The camera will create a new series of files every time the user starts recording, thus even just an hour of footage can be represented by hundreds of individual files.

As mentioned above, each clip has an associated XML metadata file. This file contains a variety of information, some of which is recorded automatically, including a global clip ID, video and audio specs of the clip, serial number and model name of the camera, and date and time of recording. Geospatial information can also be recorded automatically on certain cameras that come with built-in GPS chips. Additionally, the user can enter information, including clip names, the name of the shooter, and the place name. Some of this information – including the ID and the camera info – is also stored in the MXF video file, although this metadata is not designed to be human-readable and must be decoded.

Final Cut Pro, the editing system of choice for most of those interviewed for this paper, is designed to work with Quicktime-wrapped media. Thus, without making use of third-party software products which will be discussed later, P2 footage must be imported into Final Cut Pro with a tool called "Log and Transfer," which converts it into a Quicktime format. This process, however, eliminates most of the metadata that was stored in the P2 MXF and XML files. The Quicktime files do still contain some metadata that would allow a user to trace a path back to the original media, but it is accessible through publicly accessible tools. At this point, Final Cut does not support the AVC-Intra codec, so users shooting in that format must also transcode their media to a different codec, most likely Apple's competing ProRes 422. Avid, the other major professional

editing system, uses MXF-wrapped media, so it can work with P2 files directly, although the user can also choose to convert the media to an Avid-specific MXF format.

There are a number of other software programs on the market which can improve the P2 post-production workflow in various ways. Panasonic makes available a program called P2 Contents Management Software which functions primarily as a database for P2 media, featuring tools to copy the media from cards to a hard drive (or one drive to another) with verification, to edit the P2 metadata, and to archive the media to optical disk. However, this product is not used much among professionals, mainly because it does not work well with Final Cut or other editing systems; in fact, the file structure that P2CMS creates is often unreadable in Final Cut.[3] On the other hand, it could be used simply as a free utility for copying P2 media. Another, product that gets more use among professionals is ShotPut Pro from Imagine Products, which sells for $89. This program also handles the process of offloading the P2 media from cards and, as such, provides a valuable service. While many P2 users will simply drag-and-drop the P2 files from a card to a drive, or from one drive to another, this method can potentially introduce errors in the destination files, rendering them unplayable. Another option for this functionality is to copy the files from a Unix terminal window using the –v argument, which will alert the user if the copy has any errors. Finally, there is a class of software, including MXF4mac and Raylight for Mac which allow users to edit MXF media natively in Final Cut Pro without converting it to Quicktime. This workflow saves time and hard drive space while also allowing the user to have direct access to all of the P2 metadata during the editing process.

While Panasonic P2 was the system of choice for most of the interviewees, some were using Sony's fairly similar XDCAM EX system. The early generations of XDCAM recorded onto optical disk, but for the most recent EX system, Sony has switched to using memory cards, called SxS (pronounced "S by S"). HD footage shot on Sony's cameras is recorded in a format called HDCAM HD which uses an MPEG-2 Long GOP codec. The media is then put in an MPEG-4 wrapper which contains additional metadata. The file structure consists of a main folder called BPAV, inside which are two folders – CLPR and TAKR – and two XML files – CUEUP.XML and MEDIAPRO.XML. Inside the

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[3] The fact that the software manual is written in poorly-translated-from-Japanese English doesn't help.

CLPR folder are a series of folders, one for each clip, which contain the MP4 essence file and a series of other supporting files. There is an XDCAM plug-in available for Final Cut Pro, once it is installed, the post-production process is essentially identical to that of P2. Video can be brought into Final Cut through the Log and Transfer window which rewraps the files as Quicktime but maintains the XDCAM HD codec, which works natively in Final Cut Pro.

Case Studies

For this project, a number of people who have been using solid-state and file-based recording technology were interviewed. The interviewees include both independent video producers and employees at small- or mid-sized production companies. The works that they or their companies are producing include documentaries, reality shows, fiction works, and corporate/industrial works. While the questions varied somewhat from interview to interview, they tended to touch on a number of key concepts: the individual or company background, reasons for choosing to work with solid-state media, production & post-production workflows, archival workflows, and reasons for wanting to archive their material. A number of case studies will also touch on other important issues such as how to handle solid-state media delivery to clients. Rather than focusing on the specific pros and cons of each case study, there is a summary following the case studies which will highlight the various issues raised therein.

Case Study #1: Miguel Coyula

Miguel Coyula is an independent film and videomaker. After making his first shorts in Cuba in the late 1990s, he moved to the US and shot two features, *Red Cockroaches* and his latest, *Memorias del Desarrollo* (a reference to the classic film *Memorias del Subdesarrollo*, or *Memories of Underdevelopment*). *Memorias* was shot largely on the Sony HVR-Z1U camera, on MiniDV tape in an HDV format. However, he

also worked with solid-state recording for the first time, shooting some scenes on Sony's small-format EX1 camera, using the XDCAM EX system. He decided to shoot on solid-state because he was would be doing a lot of green-screen effects and felt that, for compositing, it would be better to shoot in true HD (1080i60) rather than HDV.

While shooting with the EX1 on location, a crew member would dump the media to a hard drive using a laptop whenever a card had been filled. A producer would convert the XDCAM footage to Quicktime files which were copied to two hard drives using drag-and-drop and returned to Coyula for editing. He is not sure what happened to the original XDCAM files, but has not had any problems or glitches arise from the converted Quicktimes.

As the project is still being finished, Coyula has not necessarily thought about long-term archival strategies, but assumes that he will store the two copies of the Quicktime media on hard drives. He has organized the media files into folders by scene but, as he has been doing all the editing himself, he has not compiled any database or media log for locating the footage.

Case Study #2: Mike Palmieri

Mike Palmieri is a cinematographer and music video director who recently completed his first feature-length documentary, titled "October Country." He first started working with P2 three years ago after working with the 200 on a job and has since used it for all of his projects: if he is shooting film, he will often use a 200 to record sound, if he is shooting HD on tape, he will use the 200 as a second camera, and he shot all of his recent music videos and "October Country" entirely on P2. He has found that shooting on P2, particularly on his independent projects, has allowed him to limit the crew size, often to just himself, and to streamline and speed up the post-production process, since he edits his work himself.

While shooting "October Country," he would copy footage from cards to a hard drive in the field, and then, at the end of the day, import the footage into Final Cut, convert it to Quicktime, and make a full copy of the Quicktime media on a second hard drive. After verifying that the Quicktime media was working, he would delete the

original P2 media. The documentary was shot over about 40 days in upstate New York; when he returned to the office after completing shooting, he copied all the media to another hard drive to use for editing. Then one of the backups was kept in the office and one was kept at someone else's house. He is still unsure about his long-term archival strategy, but assumes that he will keep both of the hard drives with full copies of all the media.

His organizational system is to keep all of the media organized into folders named with the date on which they were shot. Since he is doing all of the post-production work himself, he does not see the need in overly documenting the material or in creating other organizational systems, since he is already intimately familiar with the material.

Case Study #3: Angelo Sacerdote

Angelo Sacerdote, in addition to working as a preservation specialist at the Bay Area Video Coalition, is an independent documentary maker. For his most recent project, having decided to shoot in HD, he decided to use the 200 and shoot in DVCPRO HD 720p60. He chose not to shoot 1080, having read that the CCD chips in the 200 cannot actually capture 1080 lines of resolution, and he chose not to shoot at 24p, believing that doing so sacrifices "temporal resolution," does not actually look like film, and introduces artifacts to the video.

While shooting, Sacerdote will record both to P2 cards and a FireStore, bringing enough storage material to avoid having to offload any footage in the field. The original P2 media (and FireStore media – the FireStore records footage in the same MXF format as the P2 cards) are then dumped to a hard drive and organized into folders once he returns to the office; this drive is then stored as an archival backup. The files are copied via drag-and-drop; he will check the file sizes of the source and destination files to make sure that they match. Using Final Cut, he will then import only the shots that he thinks he will want to use, saving hard drive space by not converting everything to Quicktime.

For long-term archival, he will discard the Quicktime media and keep two hard drives with full copies of the original P2 media, using a program called Carbon Copy Cloner to make the second copy. He is definitely concerned about the longevity of the P2

file format, worrying that Panasonic's current structure is only transitional and will be replaced when the next format comes along, and he feels that it would be safer if the media were stored as a single MXF file, as with Avid or SAMMA Systems media. He has not been using any metadata presets or keeping much documentation on his storage system, but feels that he should be doing more in these areas.

Case Study #4: Jonah Volk, Simon & Goodman Picture Company[4]

Simon & Goodman (SGPIC) is a documentary production company that been in existence since the early 1980s. Run by Kirk Simon and Karen Goodman, SGPIC productions have been nominated for four Academy Awards and won three Emmys, among other awards. Their work tends to be produced for television; productions have aired on HBO, various PBS stations, and various MTV/Viacom stations. They have also done a number of work-for-hire projects, including some industrials. Productions tend to be done in a "verite" style, interspersed with sit-down interviews. The company is very small; in addition to Simon and Goodman, there is generally one other full-time staffer, in addition to freelance production crews and editors hired for specific projects.

Having started out shooting on film, SGPIC switched to digital video in the early 2000s, briefly using Sony's DVCAM system before adopting a workflow based around Panasonic's DVCPRO technology. All projects through 2006 were shot on tape using the DVCPRO50 codec, generally with Panasonic's SDX-900 camera. At that point, the decision was made to begin shooting in HD, specifically using the DVCPROHD 720p codec, using the Varicam and HDX-900 cameras. This decision, which was occasioned by the commencement of a new series for HBO, prompted a further decision to purchase an HVX-200 camera to use as an additional camera on shoots.

During production, generally only small amounts of footage were shot on P2, at most perhaps 3 or 4 cards worth during a single shoot. SGPIC owned only two P2 cards, originally 8GB cards, which were later sold and replaced with 16GB cards, so it was sometimes necessary to offload the footage in the field to a 60GB P2 store. This process

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[4] As the post-production supervisor at Simon & Goodman, I was put in the position of devising these strategies when the company began using P2. The procedures and workflows described in this case study are my own.

is fairly slow, however, requiring almost 20 minutes to copy a 16GB card, meaning that it was impossible to shoot continuously. Following a shoot, the cards and store were returned to the office, where the original P2 files would be copied to the internal hard drive on a MacPro, on which were located the original P2 media for all projects. This copying would be done by simply dragging the files from one location to the other, and no sort of checksum or quality control system was in place to ensure that the files were copied successfully. The media would then be brought into Final Cut Pro using the Log and Transfer utility, and the resulting Quicktimes would be stored on an external Firewire hard drive, along with the all the other captured media for that project.

After finishing an offline edit in the office, SGPIC would do online edits at an external post-production facility – Frame:Runner – on an Avid system. For this, the original P2 media would be copied to an external drive and brought to the facility, where it could be brought directly into the Avid project. The Final Cut Pro project would be run through a software program called Automatic Duck, which would convert it to an Avid project. The P2 media would be copied onto an internal drive by Avid, which would convert it to Avid media

For long term archiving, the original P2 media would be kept on the internal hard drive, while the Quicktimes would be deleted once the project was finished. SGPIC's goal in archiving this material was to have it available should they ever need to return to that particular project for any reason, and also to be able to incorporate the material into other projects they might do for the same client or on a similar topic. Final Cut Project files would be kept on the office computers, rather than on the hard drives with the media, and the finished shows would be output to Digibeta tape following the online edit.

Case Study #5: Huib Lirb, Dutch Indies

Huib Lirb is a Dutch videographer and producer who has worked on numerous documentaries and industrial videos over the last 10-12 years, recently through his company Dutch Indies. Since February 2008, he has shot all of his own projects, such as the documentary *The Story of Dutch Windmills*, on the HVX200 and HPX500. He has

mostly been shooting using the DVCPRO HD 1080i25 setting, but will occasionally shoot PAL SD footage for some smaller projects.

In the field, Lirb will use Panasonic's HPG10 (aka the P2 Gear), a two-slot card reader with a built-in screen for playback to offload cards as necessary onto a hard drive. On returning to the office, he will first go through all of the shot footage, including the footage that has already been offloaded and that which is still on the cards, to determine the order that the cards were shot in, using this opportunity to create a document with the serial numbers of each card and the timecode values of the footage shot on that card. He then finishes copying everything to the hard drive (via drag-and-drop) and places the media from each card in a separate named folder ("projectname" plus "date" plus "sequential number"). This folder name is also entered into the aforementioned document. Once the media has been thus organized, he makes a complete copy of everything onto a second hard drive to use as backup. He will then import all of the footage into Final Cut (which he has only recently begun using, having previously been editing on Media 100), converting all the media to Quicktime.

For long-term archival, he deletes the Quicktime media and maintains both hard drives with full copies of the original P2 media. He has not yet had to return to a project that he has archived in this way, and is wondering if he will experience any problems when doing so. He has no central database system and feels "not very comfortable with this omission," but he does keep the documents that were created when ingesting the media. He has not yet made use of any camera metadata presets, but would like to look into this, thinking that it might be more useful if he switched from using Final Cut to using Adobe Premiere, which can handle MXF media natively.

Case Study #6: Jeremy Garchow, Maday Productions

Maday Productions is a small video production company based in Chicago and run by Jeremy Garchow. The company mostly produces commercial work, internal and external corporate communications pieces, and corporate branding pieces for clients including Home Depot and Allstate. Garchow is also a forum moderator at Creative Cow, a technology information and advice website, specifically in the Panasonic P2

forum. As such, he has spent a great deal of time formulating the P2 workflows that he employs in his own business.

Garchow made the transition to a P2 workflow within the last few years and now shoots P2 exclusively. He began by using a 200 as a second camera, then began using it as a primary camera for some smaller shoots, and has recently purchased and begun using the HVX-2000. As he puts it, the process of transitioning to a solid-state-only workflow has taken some "ramp up," but he feels that the transition has been very positive. As he is often working with tight deadlines, his P2 workflow has allowed him to work faster, eliminating time that would be spent digitizing tapes. He has been shooting with the AVC-Intra codec with a 720p24 setting, finding that AVC-Intra offered better quality results and that shooting at 24p allowed for easier transitions to other frame rates, particularly if he needs to make a PAL output for a European client.

On shoots, he will bring along a 5-card P2 reader, two SATA hard drives that can be fitted into an enclosure, and a Mac laptop. While on set, once footage has been shot, he will use ShotPut to make a complete copy of all the media onto each of the two drives. Once back in the office, he will ingest the footage into Final Cut Pro using the Log and Transfer tool, transcoding the AVC-Intra footage to ProRes in the process. He has recently been experimenting with using MXF4mac as an alternative, which he likes because it allows him to work with AVC-Intra natively and to keep the P2 metadata intact.

For archival purposes, Garchow has been keeping the media on SATA hard drives, with two copies of everything. He will definitely save the original P2 media and will also save the converted Quicktime media (when it exists), except for shorter projects where he could easily re-transfer the files. He is also saving on the same drives any ancillary material that goes along with the projects: motion graphics, stills, project files, etc. As he sees it (and this is a point repeated by many of the interviewees), hard drives are so cheap these days, there's no reason not to save everything. He says that he will often get calls from former clients asking for copies of their old projects; keeping everything available allows him to quickly make new copies of anything. He has thought about the possibility of hard drive failures, but doesn't believe that there is a better alternative at this point, believing that an LTO tape backup would be too expensive and

too slow. However, he does see hard drives as an interim solution, looking ahead to the possibility of solid-state storage.

Garchow is not using any of the camera metadata presets, believing that the only useful elements are the clip name and description, which are difficult to add in the field and easy to add in the office. For archival metadata, he maintains a text file listing which shoots are located on which drives. Once he has the drive loaded up, he can find specific clips by using Final Cut's search function, finding matches from the clip descriptions.

He also described his delivery process for clients who want to receive a full copy of the media so their internal media departments can re-edit it, a situation that he says is happening more and more. In this situation, he says that the clients are always happy to receive the material on hard drive, and that he asks them ahead of time whether they want the original P2 media or the Quicktime files. Hard drive delivery is easier for them because, as opposed to tape, it is much easier to search for clips, and they don't have to take the time to digitize everything. He said that while he has gotten calls from clients complaining about tapes that he has delivered, he has never gotten a call about a hard drive delivery.

Case Study #7: John Fishback, P&P Studios

P&P Studios, run by John Fishback, is a small production company located in Stamford, CT. Their work consists of producing industrial videos, generally training videos and internal communications pieces, for large companies. Their videos are scripted in collaboration with the client, then shot with actors, dramatizing company procedures. Fishback began shooting on P2 a few years ago using the HPX-500 and has since transitioned to an entirely P2 workflow. At the time, he thought about using the Sony XDCAM (before the XDCAM EX was released), but was turned off by the optical disk recording system, wanting a true solid-state system.

When shooting, once a P2 card has been filled up, the card will immediately have its record-prevention tab switched to "safe" mode, then a crew member will insert it into a Duel Adaptor connected to a MacBook Pro laptop. From there, the media will be copied, using ShotPut, to both a two-drive mirrored RAID enclosure (RAID 1) and to a

third stand-alone hard drive. Before the card is erased for reuse, the crew member will open up the media in Final Cut, using Raylight software, and play each clip for a few seconds to verify that it copied correctly. Until the crew gets back to the office, the RAID and the other hard drive are always kept by separate people and travel in separate vehicles. When the shoot is finished, the data from the RAID will be dumped to a large hard drive in the office and used for editing, the RAID will be saved as a temporary archive while editing is taking place, and the third hard drive will be saved for long-term archive.

Once the project is finished, all of the associated files will be added to the backup drive along with the original P2 media. Given the nature of Fishback's work, he tends to not shoot very much footage for any project, so he is easily able to fit everything from a project onto a single 500GB hard drive. He will create a text document for each drive listing the complete contents of that drive, along with the client's name and contact information. Also, rather than using the camera metadata presets, he simply uses a slate at the beginning of every shot, thus making the thumbnail image for that media clip include all of the information that he needs. According to him, there is not necessarily much need to archive his work because clients very rarely ask for old projects, but he still feels it necessary to save his work. He has thought about backing up onto LTO tapes, but he feels like it would be "overkill" for the work he is doing, primarily due to the associated startup costs.

Case Study #8: Tim Pastore, Original Productions

Original Productions is a mid-sized production company (the company has approximately 25 employees) in Los Angeles that produces a number of reality/documentary television series, including "Ice Road Truckers" and "Deadliest Catch." One of their most recent productions was "Iditarod," a six-episode series about the famed Alaskan dogsled race. Tim Pastore worked as a supervising producer on "Iditarod," which was shot entirely on P2 cards. Original's other shows were mostly being shot on tape, but the decision was made to shoot "Iditarod" on solid-state media

due to the extremely cold weather conditions in which the series would be shot – tests showed that any moving parts in the cameras would freeze up.

The show was shot by multiple crews over the course of about two weeks in March at locations throughout the Alaskan wilderness. The team, led by Pastore, brought along 20 HVX-200s, 124 32GB P2 cards, and 72 terabyte hard drives. Crews would always have enough P2 cards on location to avoid having to offload any footage in the field – it would have been too risky to try to use laptops on location. Once a crew was finished for the day, a crew member would use a 5-card reader to dump the media onto two SATA hard drives in a Wiebetech enclosure using a mirrored RAID 1 system. If possible, he said, he would have preferred to shoot on tape, feeling uncomfortable having so much footage on a hard drive that could fail. In fact, he had multiple hard drive failures on location and had to restore the footage from the backup drive.

The crews would use some of the camera's metadata presets, entering the shooter's initials and the location of the shoot, specifically the Iditarod checkpoint. The cameras with built-in GPS had not yet been released, but Pastore would have liked to use them to automate the location metadata gathering. On the hard drives, the footage was organized into folders, first geographically, then by date and shooter. During the first step of post-production, the footage was ingested into an Avid system where assistant editors entered a log line for each clip, using special keyword dictionaries. This information was then entered into a Filemaker Pro database that was maintained on Original's servers, so that any editors could search it to find specific clips. His work is more production-oriented so he was unsure about the long-term archival plans for the media, but he assumes that the two copies of the material will be maintained on hard drives, probably at separate locations. The finished shows were exported to HDCAM and Digibeta tape masters for broadcast, which could then be archived both by Original and in Discovery's tape library.

Pastore also discussed Original's footage delivery process. Discovery, like many networks, requires production companies to deliver all shot footage on completion of the project. As work-for-hire, the network owns all the raw footage and will often repurpose it in other shows or use it as stock footage. Discovery had previously required that all deliveries be done on videotape, forcing the production companies to spend the time and money to transfer all the footage. "Iditarod" was one of the first shows for which

Discovery allowed a hard drive delivery, taking all of the original P2 media, along with the Filemaker database, for use in their own archives.

Case Study #9: WNET

WNET, a public television broadcaster in New York City, has recently begun producing some of their shows on P2, notably the series "WorldFocus," an international news program. This move to solid-state recording came about as an attempt to make WNET's post-production workflows more efficient, allowing all media transfer to be done in one central location without taking up time in more expensive edit rooms. WNET is obviously not a small production company, but their P2 workflows will hopefully prove instructive, despite the contrasting environment. The people designing these workflows, specifically Digital Media Archivist David Rice and Technology Project Manager Jonathan Marmor, have a much more difficult job than the interviewees from the other case studies. While the others are able to implement the workflows themselves, generally both in the field and during post-production, Marmor and Rice must design workflows to be used by production crews and post-production staffers who are may not interested in the archival process. Thus, any methods that they devise must be very simple, ideally even automatic, or else they run the risk of their methods being ignored or botched.

As a result, Marmor and Rice have created a number of in-field media management guides to be used by WNET production crews. These guides cover the creation of proper file structures – a series of nested folders named for the show, session and card – as well as guidelines for saving the footage to two separate hard drives and importing and logging footage in Final Cut. The guides contain no specific instructions for verifying that the footage has been copied correctly. Rice mentioned that he has been trying to work on this aspect of the workflow, particularly since one producer managed to lose all the footage from a shoot when the media somehow got completely scrambled during copying.

After the shoot, the footage is brought to the Convergence Lab at WNET where the media is moved onto the WNET servers. At that point, a Lab staffer will use a series

of scripts created by Rice to make Quicktime reference files from the P2 media. Quicktimes will be created for each card and by concatenating these together, for each complete recording session. These reference files can then be used for Final Cut editing but, as they are only reference files, they take up a fraction of the space that stand-alone files would. The session files allow editors to work with footage as one unit, rather than broken up into many little pieces, as they ordinarily would be.

Rice has created a number of scripts which can extract technical metadata directly from the P2 media files, as mentioned earlier. This automatic metadata can then be combined with human-created metadata that WNET requires its producers to enter, all of which will be put into PBCore records that can be stored in a Filemaker database. Because there is so much metadata stored in the P2 files, Rice sees the saving of the original media as a necessity. However, recognizing that the P2 MXF format may not continue to be viable in the long-term, he is also creating stand-alone Quicktime files that can be stored, along with the original media, on LTO tape via WNET's standard backup system. WNET, along with the Preserving Digital Public Television at NYU, is investigating strategies for storing the finished shows in a file-based format, rather than having to output to tape; this currently ongoing work has been well-documented by David Rice and Kara Van Malssen.

The Specialist: Andrew Shipsides, Abel Cinetech

In conducting the above case studies, it became clear that one of the reasons that so many different archival strategies exist is because Panasonic and Sony, the companies that have created these technologies, have not been particularly helpful in suggesting courses of action. Panasonic, for example, has on its website a number of white papers on P2 workflows, but none of them deal with archival issues. In this information vacuum, users are left to devise their own strategies, or to turn to more experienced users, by viewing Garchow's online tutorials, for example. Retailers who specialize in solid-state equipment can also be a valuable resource. New York's Abel Cinetech is one such retailer, offering hands-on tutorials to customers and potential customers, as well as helpful white papers and tutorials via its website.

Andrew Shipsides, Abel Cinetech's P2 specialist, was able to offer some interesting insights into solid-state archival issues, particularly in the area of long-term archival. While several of the other interviewees dismissed LTO data tape as a viable archival strategy, Shipsides believes that it is the best option currently available, even for small production companies. The tapes are believed to be more reliable than hard drives and while the start-up cost (buying the drive) is high, the tapes are cheap. Using the opportunity to plug Abel's service, he mentioned that they will copy media from hard drives to LTO tape for customers, although this obviously slows down the time to read from and write to the tapes, already slow processes. He mentioned another issue with LTO tape – there is no single compression system used. A number of different systems can be used, and the data can only be uncompressed with the same system. Another potential issue with LTO is that new versions of the format are always coming out – the current format is LTO-4. It might be possible that, in the future, LTO-4 would no longer be supported, forcing users to migrate their data to new generations of tape.

Shipsides was also helpful in offering some general P2 tips, which have been incorporated into the recommendations below. When asked about Panasonic's official position on archiving P2 media, he said that there is none. Panasonic has put out a white paper on metadata strategies, but nothing for general archival strategies.

Case Study Summary

From the above case studies, it is clear that, each interviewee is, in some way, thinking about archiving their solid-state-acquired media, even if the resulting strategies are at times lacking. This is perhaps obvious – given that they are all coming from a tape-based workflow, they are used to saving their original media. The challenge has been to adapt to a system where archiving is no longer as simple as just putting tapes on a shelf.

The most successful strategies would seem to be those that push archival thinking as early into the production process as possible. Consider P&P's system for in-the-field archiving – by ensuring that every full P2 card is immediately put into safe mode and

copied, with verification, to two hard drives, John Fishback is able to greatly reduce the chance of any footage being lost. Of course, P&P has the great advantage of shooting scripted work with actors in a controlled environment. While documentary-makers may not be able to do as much in the field, they can utilize similar processes at the end of the shooting day, as Original and Angelo Sacerdote are doing. The longer the wait between shooting and archiving, the greater the opportunity for the footage to be lost.

Another issue that comes up in many of the case studies is file verification while copying. Simply dragging and dropping files from card to drive or from one drive to another, as Simon & Goodman, Sacerdote, and even, in many cases, WNET are doing is highly risky behavior. There are a number of tools that take care of the copying process and perform automatic verification, including the free P2CMS and the relatively cheap ShotPut, which can eliminate this risk. Further verifying each clip by playing it back, as Fishback does, adds yet another level of security, but, given the time expenditure, may be overkill.

An important issue to consider here is the extent to which long-term archival strategies will be successful not just for the original creator of the material, but for an archivist who may be trying to work with the material in many years' time. It is here that documentation and metadata truly become crucial. Several of the interviewees, particularly independent producers like Coyula or Palmieri, had very minimal documentation of their footage. While this may be fine in the short-term, since they already have a close knowledge of their material, it would present quite a problem to a future archivist. Even if their footage was completely intact, a lack of organization and documentation could render their footage unusable.

Continuing in this line of thinking, any efforts towards building metadata into the original P2 media files, by using camera presets, as Original and WNET are doing, by entering data later using a tool such as P2CMS can pay off in the long run. Even shooting slates at the beginning of every shot like P&P, can be helpful – the slates would not be machine-readable, thus hampering any attempt at automatic metadata gathering, but they could still be valuable if there is little other information on the footage. The more information that is contained in the files themselves can be a boon to a future archivist, even if written documentation is lacking. Similarly, some of the interviewees,

particularly Huib Lirb and Tim Pastore, are building metadata into the file structure by intelligently labeling the folders containing the media.

Almost all of the interviewees (everyone but Simon & Goodman) describe making two copies of the media while in production, certainly a good strategy, as it is when dealing with any kind of digital material. It is important, however, to extend this backup system beyond the production process and, as described in many of the case studies, maintain two copies of the material long-term. Equally important is the disaster-prevention strategy of keeping the copies in separate locations, as mentioned by Palmieri and Fishback.

Finally, there were a number of different opinions regarding which media to save. Some are saving just the P2 original media, some just the Quicktimes, and some both. It seems like David Rice from WNET expressed the best rationale for keeping both; this would definitely seem to be the safest option, particularly as hard drives continue to drop in price. If saving both is not an option, presumably for cost-related reasons, it is definitely better to save just the original media – as Jeremy Garchow points out, the Quicktimes can always be recreated from the P2 files, while the P2 files can never be recreated once they are deleted.

Long-Term Archival Solutions

Below is a list of potential long-term archival strategies, some of which have been mentioned above. For each strategy, pros and cons are mentioned. Anyone considering using any of these methods should evaluate their storage needs and budget before choosing one method.

P2 Cards (or other memory cards): While permanently storing material on P2 cards seems ridiculous, several interviewees mentioned hearing about people who were doing this. May be just rumors. In theory, solid-state storage is a good idea, but the cost per GB is currently far too high.

Pro: Long-term reliability

Con: Massively expensive (a 64GB card costs $2500)

Videotape: None of the interviewees are outputting their material to tape for archival, but Pastore mentioned having to do this for footage delivery in some cases.

Pro: Fits into traditional archival scheme

Con: Huge time expenditure. Requires downconvert if AVC-Intra or other better-than-DVCPRO HD codecs are being used.

Optical Disk: None of the interviewees are using this method either, but it may become more popular as the price of BD-R disks drops.

Pro: Unclear

Con: Slow read & write. Too expensive (around $20 for 50GB)

Hard Drive: The choice of many of the interviewees. Certainly workable, but not necessarily reliable in the long term.

Pro: Fast read & write, reasonable cost per GB (some 1TB drives sell for as little as $100)

Con: High failure rate (relatively speaking)

LTO Data Tape: The long-term storage of choice for many larger institutions, broadcasters, etc.

Pro: Long-term reliability (in theory), tapes are cheap ($30-45 for 400GB)

Con: Slow read & write, high startup cost ($7-800 for a drive), potential readability issues re:compression systems, potential need for migration as older versions are no longer supported

Recommendations

The following, a sort of summary of the above summary, are a few basic points that will hopefully lead to better solid-state archival practices. Obviously, these may not

work for every individual or organization, but they should all be adaptable to multiple situations.

1. Before beginning a plan, formulate an archival strategy. Think out the entire production, post-production and archival process. Read Panasonic, Sony, or third party materials on workflows and metadata practices.
2. Make use of metadata presets. Individual clip information can be difficult to enter in the field, but session information such as project name, shooter name, and location can be entered at the beginning of the day.
3. Write-protect cards as soon as they are removed from the camera and definitely before they are inserted into a computer, adaptor or card reader.
4. Offload material from cards as soon as possible, either during the day or, if that is unworkable, at the end of the day.
5. Use a copying method with built-in verification, P2CMS or ShotPut, for example.
6. Don't change the names of any original media files and keep the original file structure intact. Create a meaningful file system into which to insert the existing files.
7. During post-production, create and maintain two full copies of the material. Keep the copies in two different locations.
8. For long-term archival, definitely maintain the original media. If storage space is not tight, consider maintaining the Quicktime media (if any was created during post-production) as well.
9. Keep all ancillary media (project files, motion graphics, stills, music) along with the media, such that the project could be completely recreated.
10. Create a database with all of the production and post-production metadata, including, if possible, logged clip information. The database should indicate the location of all the files, and should be stored along with the media.
11. If hard drives are being used for long term storage, continue to maintain two full copies of the material. Spin up the drives every six months to ensure their continued viability.

The Future

One sentiment expressed by several of the interviewees is that P2 is merely a transitional format as the industry moves to more high-quality solid-state media systems. The most notable such system currently in existence is the RED camera, which can record on Compact Flash cards or hard drives at resolutions of up to 4K. While it is currently mostly relegated to high-end productions – feature films, some music videos and commercials – the company will soon be releasing its Scarlet camera, which will have similar specs and be priced more for the small-scale professional market – precisely the types of individuals and companies described above. These cameras record in the Redcode codec, introducing yet another compression scheme for archivists to deal with.

At the same time, companies like Panasonic, Sony, and JVC are introducing new tapeless consumer-grade camcorders, which record to a variety of different formats (SD card, DVD, hard drive) using a variety of different codecs (AVCHD, MOD, TOD). As these cameras become more ubiquitous, they may even start to take over the lower end of P2's domain.

The end result of these maneuverings is unclear, but it does seem likely that P2 and other mid-range systems will have a limited lifespan on the market. Obviously this affects long-term archiving strategies, particularly if (when?) Panasonic no longer supports the P2 file system. Moreover, the profusion of new formats will create an even bigger headache for future archivists. Even if the market settles on some small set of formats, there will still be a great deal of footage from these transitional years to deal with. While the above archival strategies and recommendations may become outdated, the core theories will not. In this situation, perhaps the best advice is the simplest: save everything on durable media and keep good metadata in a readable format.

Further Reading

Panasonic's P2 White Papers:
http://www.panasonic.com/business/provideo/p2-hd/white-papers.asp
including:
Metadata Workflow White Paper:
ftp://ftp.panasonic.com/pub/Panasonic/Drivers/PBTS/papers/P2HDMetadata.pdf
P2-Final Cut Pro Workflow White Paper:
ftp://ftp.panasonic.com/pub/Panasonic/Drivers/PBTS/papers/Apple_Final_Cut_Pro2008.pdf
AVC-Intra White Paper:
ftp://ftp.panasonic.com/pub/Panasonic/Drivers/PBTS/papers/WP_AVC-Intra.pdf

Sony's HDCAM EX Site:
http://pro.sony.com/bbsc/ssr/micro-xdcamexsite/

Jeremy Garchow's MXF4mac Video Tutorial:
http://library.creativecow.net/articles/garchow_jeremy/dvc_pro_hd.php

Shane Ross's Importing P2 into Final Cut Pro 6 Video Tutorial:
http://library.creativecow.net/articles/ross_shane/p2fcp6.php

Avid's P2 Tutorial:
http://learn.avid.com/content/tutorials/P2/tutorial.html