Current Practices in

Capturing Live Performance Events

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Table of contents

Introduction 1
  Background 1
  Who Should Use this Document 1
  Budget Categories 2
  Analog vs. Digital: Considerations for Performance Capture 2
Getting Started 3
  Description of Capture Scenarios 3
  General Resources and Requirements 3
  Resources Specifically for Capture 3
Factors to Consider During the Capture Process 6
  Digital Production 6
  Rights & Releases 8
  Preservation 8
  Users & Use 9
Lighting 10
  Lighting Basics and Implications for Lighting 10
  Summary Recommendations for Integrating Captured Images into Live Performance 12
Video 14
  Camcorder Features and Functionality by Format 14
  Amateur (MiniDV) 14
  Prosumer (DVCAM/DVCPRO) 14
  Professional (Digi-Beta) 14
  Overview 14
  Multiple Camera Options 18
Audio 19
  Microphones 19
  Recording Audio for Audio-Only Archives 19
  Audio-Only Choices and Tradeoffs 21
  Recording Audio for Video Archives 21
  Audio for Video Choices and Tradeoffs 22
  Additional Audio for Video Information 22
  Tips and Techniques for Better Sound 23
Appendices 24
  A) Bibliography & Further Resources 24
  B) Notes on Other Relevant Guides 26
  C) Authorship and Contact Information 26

Introduction

Background

The mission of the Performance Archive & Retrieval Working Group is to propose standards and best practices for documenting, archiving, and retrieving the recordings of performances in the new digital environment. From the charter:

> Advanced networks in combination with other developments in information technology, such as digital video/audio capture and synthesis, make it possible to document live theatre, musical compositions, dance and other performance in new ways. These developments also allow for the creation and documentation of new genres of performance such as collaborative distributed musical theatre events. These materials will be important in the future scholarship of the arts and humanities. They will be an integral part of new theses and dissertations and also of scholarly publications. [Introduction 8]

As part of its output, the working group has drafted two guides, one for capturing live performance events and one for managing the digital assets created as a result of that capture.

The aim of this document is to provide a basic primer for people creating and/or archiving digital recordings of live performances and performing arts events in research and/or educational environments. Although we provide a fair amount of detail, our goal is not necessarily to teach people all of the technical details involved; rather we hope to give a thorough overview of all of those details. We wish to be informative enough that, upon reading this guide, users feel that they know the right questions to ask expert staff, and start building their own expertise.

This document has been produced by the Performance Archive & Retrieval Working Group [Introduction 7*], jointly sponsored by Internet2 [Introduction 4] and the Coalition for Networked Information (CNI) [Introduction 1]. Internet2 is a consortium being led by over 200 universities working in partnership with industry and government to develop and deploy advanced network applications and technologies, accelerating the creation of tomorrow's Internet. It is recreating the partnership among academia, industry and government that fostered today's Internet in its infancy. CNI is an organization dedicated to supporting the transformative promise of networked information technology for the advancement of scholarly communication and the enrichment of intellectual productivity. Some 200 institutions representing higher education, publishing, network and telecommunications, information technology, and libraries and library organizations make up CNI's membership.

Who Should Use this Document

This document is written for people concerned with how to best capture digital recordings of live performance in research and educational settings including, but not limited to:

A) University departments, institutes, centers, etc. in several fields: performing arts, anthropology and ethnology, ethnomusicology, folklore, etc. who want to record student or faculty performances, or who are doing field research involving live performance.

B) Media and/or Information Technology centers who may be responsible for maintaining capture equipment.

C) Libraries and archives with collections of such recordings/files who would like to know more about how these holdings are created.

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* This document's bibliography is organized according to its section headings. Within each section, references are arranged alphabetically. So, for example, the pointer "[Introduction 7]" refers to the seventh listing in the Introduction section of the bibliography.

We expect that librarians and archivists will also be interested in our digital asset management guide.

Budget Categories

We have tailored our recommendations towards three budget categories: Consumer, Prosumer, and Professional. These represent increasing levels of available resources, more specifically of funding and technical skills. With each jump in budget category, not only will the equipment be more expensive and of higher quality, it will also be more powerful, allowing greater functionality and better results. However, because of this greater flexibility, 'professional' level equipment may very well require professional users. Again, the purpose of this guide is not to teach someone to become such an expert, but rather to give them:

A) The skills to get good results working with more basic equipment that does not require extensive expertise to use, and/or

B) The background necessary to be able to talk intelligently with experts about what they would like to accomplish.

Analog vs. Digital: Considerations for Performance Capture

This is a guide to current practices. Because the field of digitally-recorded performance is so new, we do not feel confident that there has been enough time for institutions to codify 'best practice.' For example, there is no general consensus that digital formats have the qualities that would make them ideal formats for preservation/archival purposes (at least, not yet). Nevertheless, in this guide we have made a decision to forgo recommending analog formats (even popular ones) in favor of recommending only digital ones. Our reasoning behind this decision is hinted at in the quote from the Working Group's charter that opens this document. While analog collections of live performance recordings have been—and remain—vital to our artistic heritage, many of the newest methods of creating and documenting performance are enabled by digital technology.

Many attitudes about the digital delivery of resources are based on a linear, passive, one-dimensional mode of thought shaped by commercial television. However, digital capture offers the opportunity for a richer set of options and products. Among these is the delivery of raw streams of output and/or multiple derivative resources created from the captured data. One of the exciting features of the digital domain is that a variety of outputs can realistically be produced in cost effective ways. For instance distributed multi-site performances and the use of content-based audio/video search and retrieval tools are both made possible by the availability of advanced networks to distribute digital performance collections. Multi-sensor capture can be delivered to users much more meaningfully in the digital environment. It is the current practices associated with these sorts of cutting-edge applications that we hope to document here.

Getting Started

Description of Capture Scenarios

In addition to the three budget categories, we have made our recommendations on capture with three scenarios in mind: Fixed Site, Fieldwork/Mobile Setup, and Multi-Site. A fixed-site scenario is fairly self-explanatory. It describes a capture taking place in a site—most likely a recording studio or specially built theatre or concert hall—that is designed for digitally recording live performance. By contrast the fieldwork/mobile setup scenario is geared towards people who are out making live recordings in places that are not designed for digital recording. This category is not only applicable to people recording 'out in the field', but also to people recording in more traditional performance spaces—without digital recording facilities—at their home institution. Finally, the multi-site scenario describes recommendations for capturing a collaborative, distributed performance, such as Dancing Beyond Boundaries [Getting Started 4] or The Technophobe & The Madman [Getting Started 11].

General Resources and Requirements

Institutional resources required to support a project or program fall into three categories: human resources, equipment resources, and resources that support sustainability. Human resources include technical, production, and administrative staff. Equipment resources include all the required physical devices, although this document will focus on the computing (e.g. networks, storage, operating systems, applications, etc) and other electronic (digital video cameras, microphones, etc.) resources. Finally, funding and sustainability need to be taken into account. If the collection is being built as part of an ongoing program—as opposed to a limited-term project—it needs to be able to carry on its activities for the foreseeable future. Hidden, diffuse, and ongoing costs—such as those incurred by loss of expertise through staff turnover, maintenance of physical facilities, and payment of staff salaries—need to be covered. The program need not necessarily cover its own costs, but these costs must be taken into account, and renewable sources of funding must be lined up. Even if the collection is organized as a project, with a definitive end date, these issues cannot be entirely ignored. Moreover, some projects wish to evolve into programs. In these situations, project leaders should plan for (possibly) more complex costs, as well as ongoing financial support, as part of their transition. For more detailed information, see the 'Resources' and 'Sustainability' sections of the NINCH *Guide to Good Practice* [Introduction 6].

Resources Specifically for Capture

In all scenarios capture requires sensing/pickup, recording, and editing equipment, and possibly authoring equipment (for CD and/or DVD creation) as well. The computer workstations used for video capture, especially, must be capable of intensive processing. Part of the purpose of this guide is to help readers choose what equipment features are useful (or necessary) for which purposes; to that end some discussion of specific technical attributes of capture technology is spread throughout these guidelines. Depending on the project, people skilled in film/video recording and/or audio engineering may also be required.

The capture system for fixed-theatre work is the most familiar set-up. Variations might include multiple camera and microphone rigs/stations, on-site mixing booths, and direct connections to digital asset management system accession streams. The first requirement for fieldwork equipment is portability. In remote areas or mobile shoots, this may mean lighter-weight cameras and microphone rigs, multiple battery packs, and possibly equipment to do on-location film/video or sound editing. Multi-site work requires advanced networking capabilities, including some form of either streaming audio/video or other high-end videoconferencing system.

Indeed, although the topic is also dealt with in the sections on video and audio, it is useful to give an additional note on synchronization here. The problem of syncing multiple camera and/or microphone feeds to each other affects all but the most basic capture situations. Audio captures using a single microphone and video captures using a single camcorder—and using no sound other than that picked up by the camcorder's built-in microphone—are the only situations that can avoid the need to sync. There are two situations that will be covered here: syncing multiple cameras to each other and syncing one or more audio feeds to a video signal. Each situation will likely require special equipment in terms of cabling, adapters, and so on, and will certainly require the expertise of a digital video production specialist and/or an audio engineer.

Synchronization of Multiple Cameras to Each Other

While commercial editing software makes it possible to sync various media streams (including both audio and video) to each other manually during post-production, this method depends on the eye and ear of the user. There are also ways of automating synchronization by reliance on the timecode embedded within the video signal. While many cameras have a system for internal syncing—that is a system to synchronize signals from multiple CCD sensors and combine them into a single image—syncing multiple cameras to each other requires a method for the external synchronization of cameras. External syncing in video production is usually accomplished by "genlocking" cameras together. Genlock is a process whereby multiple cameras (or other video devices, such as recorders and editing consoles) each follow a timecode signal sent out by a lead camera, and adopts this propagated signal as their own.

As a result, instead of a loosely-coupled system of cameras that more or less share similar timecode information—e.g. as when multiple cameras are set to record at the 'same' time—the cameras genlocked together become a tightly-coupled system; the cameras are all synchronized to the absolute same time signal. (Traditional technical terminology refers to the cameras that receive timecode information as being 'slaved' to the single 'master' camera that propagates its timecode signal throughout the system.) Here are some websites with more information on syncing:

- http://www.videonics.com/articles/mixing.html Videonics. "Mixing Video Sources: All About Video Mixers, Time Base Correction, Frame Synchronization, and Other Digital Video Concepts."
- http://www.mivs.com/technical/appnotes/an005.html MicroImage Video Systems, "An Overview of Genlock."
- http://isb.ri.ccf.org/biomch-l/archives/biomch-l-1996-09/00050.html A compilation/how to of various methods for gen-locking specific cameras from a biomechanics email list.

Synchronization of Audio to Video

A video frame is either 1/24th or 1/30th of a second long. Because individual sounds, such as short consonants and sudden noises, can be much shorter than a single video frame in length, syncing audio to video is more complex than merely getting all of the video frames to match. The process of syncing audio to video is a very specialized art, requiring extra equipment such as XLR connections in the camera (or adaptors) to allow for balanced, analog audio input from external sources. Again, there are different approaches to syncing audio to video. At the most basic, if camcorders' built-in microphones are used, multiple cameras' audio tracks can be synchronized by syncing the various video feeds as in the section above. More common in shoots where sound quality is of great importance is manually syncing audio to video by the use of slating, the process of matching a short, sharp sound to a specific visual event

- http://www.cinematography.net/sync%20without%20slate.htm "Sync without slate" compiles suggestions for how to sync audio to video without actually clapping a slate.

Also, although we don't address it in this document, cutting-edge live performance sometimes incorporates technologies such as live motion-capture of dancers (to project their digitally altered images on screens during the performance), or performances involving choreographed/programmed robots. The capture of these types of performances have their own unique requirements in addition to those we've mentioned above. (Also see "Archiving the Avant Garde" [Getting Started 1].)

Factors to Consider During the Capture Process

When capturing a performance event for archiving in a digital collection, the answers to a number of questions will have an impact on the recording process. Following is a list of some of these questions:

Digital Production

- What is the intended storage medium/destination?
- How will the recordings be kept? (Will tapes/discs get reused? How limited is the stock of storage medium, be it tape, hard disk, etc.?)
- What information about the performance and its recording (i.e. what metadata) will get collected at the time of the performance, what will be added during post-production, and who will be responsible for ensuring that all necessary information is collected?
- How will metadata—necessary for preservation as well as for retrieval, administration, and use—be integrated with the digital resource?
- For more about metadata, see the Metadata section in *Current Practices in Digital Asset Management*.
- What editing and other post-production processes will the recording(s) undergo before they're ready for consumption? Although some uses of the term restrict 'consumption' to the playback of material by end-users, consumption at its broadest is the acquisition and use of material at any point 'downstream' of the current process in question. Just as content aggregators dealing with consumption need to concern themselves with questions on end-user needs, rights, and restrictions, so too content creators may need to concern themselves with similar issues in regards to repositories. During production and post, capture teams may want to consider what sort of editing processes different audiences will want, need or expect to have been performed upon the materials they receive.

    ***Editing source material and output*:** The capture of a performance will likely involve more than one sensor device, i.e. it will likely involve a combination of cameras and/or microphones. Thus, it will result in more than one stream of audiovisual material. Feeds from individual cameras and microphones are mixed into a 'final,' master version, the main questions being 'how much' and 'when.' While these streams may be mixed live to create an edited version on the spot, they may also be recorded and saved individually, with editing processes saved for a post-production phase of the project. (Alternatively, a combination of these two approaches may be employed, with an on-site mix being supplemented by the presence of raw streams.) If the raw feeds are kept, any edited version may later be either re-mixed or created entirely anew by going back to the original feeds. This can be useful not only in cleaning up or correcting errors in an unsatisfactory edit, but also in repackaging the material in new derivative products with different features or aimed at different audiences. Digital environments allow for new possibilities in this arena. For example, with film and magnetic tape, editing decisions create physical manifestations of the edit as the media are spliced together. With digital media, it is possible to create an edit without any physical manifestation thereof: it can all be done with metadata (for example, an edit list that details and links to the start and end times of the appropriate segments).

    ***Other post-production processes*:** While mixing individual media feeds into a master edit is one aspect of post-production, digital streams make other enhancements more feasible as well. For example, color grading, noise reduction, and compression processes may be applied to media during digital post-production. However, some of these processes can occur at multiple points in the project. Productions need to be aware of what steps have been taken in regards to which media streams. Compression, especially, needs to be tracked. Compression in this case is a way of reducing (normally huge) multimedia file and/or stream sizes by either compacting or eliminating audio or video signal information that is less important for human comprehension of the signal. (This is not to be confused with audio line limiting, also sometimes called compression, which is a way to reduce excess volume in an audio feed.) Cameras, recording units, post-production processes, and digital file transformations for delivery may all apply compression (sometimes different types of compression) to a track. For example, digital camcorders, which combine cameras and recording units, almost universally apply some sort of compression scheme to both the audio and the video recorded with them.

Because compression can occur at so many different steps in the overall production process, it is important to know a little about the pros and cons of compression during capture, as opposed to during final distribution, as well as the effects of multiple compressions on a track. There are many different audio and video compression schemes; some of these, such as MPEG-1 (including MP3), MPEG-2, MPEG-4, and H.323, are associated with file distribution while others—like those used in MiniDiscs and Digital Betacam and DVCPRO cassette tapes—are associated with capture. Moreover, each scheme may have several codecs (compression/decompression algorithms) associated with it. For example, the MPEG standards focus on playback, and do not specify which codec an encoder must use to start with. As such, there are several different methods for encoding MPEG files. Compression can be either lossless, which preserves all of the original signal information but results in large files sizes, or lossy, which can significantly reduce size by eliminating 'redundant' or 'insignificant' signal information. Most audio and video compression schemes, whether at the camera/recording end of production or at the file distribution end, employ lossy compression methods. Because it discards information, any artifacts that lossy compression introduces into video and audio streams cannot be easily reversed. Re-compressing a previously compressed file or stream exacerbates these effects, which is why project teams need to be aware of when and where compression occurs in their production process. Here are some websites that discuss compression further:

http://emusician.com/ar/emusic_cramped_quarters/ "Principles of Audio-Data Compression," from *EMusician*.

http://www.digitaltelevision.com/publish/dtvbook/ch2.shtml#video The Guide to Digital Television, Third Edition. Section (from Chapter 2) on Video Compression.

http://www.theforce.net/theater/postproduction/compression/compression01.shtml overview of different MPEG compression codecs.

http://videosystems.com/ar/video_bonding_bandwidth/ An introduction to video and audio over computer networks; touches on compression, as well as broadcast of live events, in terms of bandwidth and server/network capabilities.

As may be inferred from the above, versioning is an important consideration. Each process will result in additional output streams, each of which must be labeled, stored, and tracked. For example, a video production may have both raw footage and color-graded footage from multiple cameras on hand, as well as various audio streams. During editing, it will be important to distinguish each of these streams from each other, as well as from the eventual edited master stream.

Consumption**:** Audiences can vary widely in expectations and capabilities. For example, in a capture of a collaborative performance involving several organizations, the host organization may put together a 'master' mix meant to distribute the performance as a whole to collecting repositories and/or the general public. Meanwhile, the other organizations involved in the event will also receive capture materials. While some performing groups will want the fully-edited version created by the host institution, others will want raw streams, expecting to perform post-production processes on the material themselves. The capture and preservation of all of the raw audio and video from the event will allow these groups to create mixes that showcase their involvement with and performances in the overall collaboration.

Rights & Releases

- Who owns the final product?
- What permissions need to be obtained and from whom? Releases from performers should include not only the initial capture of the performance and its distribution via traditional media, but also possible subsequent distribution on the web and the creation of derivative resources. However, will the performers, presenters, or others in the recording retain copyright to their contributions, or will this be assigned to the institution? Jill Gemmill from the University of Alabama at Birmingham has compiled several examples of release forms and put them up on the ViDe website at http://www.vide.net/resources/forms/.
- What provisions are in place to ensure the privacy of students, research subjects, and other protected performers? The policies of individual educational institutions' Institutional Review Boards (IRBs) may be a matter of concern in some collections of performances used in ethnographic research; also of concern is the Family Educational Rights and Privacy Act of 1974 (FERPA) [Getting Started 6], which regulates the use of and access to student records:

  IRB policies, which govern the rights of human subjects when they are used for research, tend to be more of a concern in medical and psychological research than in anthropological or ethnographic research. However groups and individuals capturing anthropological/ethnographic performances are not exempt from IRB review, and moreover need to consider ethical and scholarly principles in addition to legal and regulatory obligations. For example, many issues relating to appropriation of a group's cultural heritage, the rights to national patrimony, the ownership of folklore, etc., have not been fully resolved; capture projects may need to consider how they will approach these areas.

  FERPA gives students the rights to view and amend their student records, as well as some control over how and to whom those records are disclosed. FERPA regulations place strict limits on the dissemination of personally-identifiable information, i.e. information with which people might identify or locate students without their consent. Usually this means name, address, contact, and other demographic information. However, because video, especially, captures information about student performers that can help identify them (e.g. their pictures), repositories need to take care to accommodate FERPA regulations if they cannot be sure that the students in these recordings have waived control over their access.
- For more on rights, releases, and other intellectual property issues, see the Intellectual Property section in *Current Practices in Digital Asset Management*.

Preservation

- How unique and/or valuable is the recording?
- How will it be preserved?
- How long will the recordings be kept—e.g. will they go into a permanent archive?
- How many versions of the recordings will be maintained? (E.g. will there be separate archival and use copies? Copies in different formats for use with different operating systems?)
- For more on preservation issues, see the Preservation section in *Current Practices in Digital Asset Management*.

Users & Use

- How will the resources be viewed or delivered? What derivative products will be created from the original resources, and how will these be disseminated? (Will there be downloadable or streamable versions of the resources for patron use? Will the resources only be available onsite, or will they be accessible through the intra-campus network? If multiple versions are made, to what circumstances will they be tailored, e.g. will professors be able to view them streamed over a 56K modem from home, or will they only be available on relatively high-speed campus networks?)
- What kinds of users will access the finished product: researchers, students, the general public, professional artists, others?
- Which group(s) is your primary focus?
- What will users want to do with the recordings?
- How much second-guessing of users' needs and wants is permissible? (E.g. eliminating and/or lessening audience and other background noise through re-mixing may be requested by music theory researchers and not at all wanted by ethnomusicologists. Or both groups may prefer to have such 'primary source' evidence left unchanged so they can make their own judgments on the material.)
- What is their level of technical expertise?
- What playback software are they likely to have?
- Will it be necessary to document the positioning of microphones and other equipment? Users may want to know about acoustic factors such as the balance of sounds, timbre, and bias attributable to the placement of sensing and/or recording devices. This factor is more relevant in field studies and research settings. For example, conductors or music students comparing two or more orchestras' recordings of a symphony may need to know if the recordings sound different due to the orchestras' different musical philosophies or due to their different recording setups. If this is a consideration, how will it be documented?

Lighting

Live performances—all theatrical in the sense that they occur onstage before an audience—have very different lighting requirements than performances for film and/or video. The human eye can register significantly more contrast and color than film and video cameras can. Along a number of ranges, including light intensity, image resolution, color gamut, light/dark contrast, and so on, the eye can detect both larger spectra and more subtle distinctions within those spectra. Moreover, while such considerations affect all productions that are taped, they also affect live productions that include projected images as part of the performance. Any live production that incorporates video recording—whether as an integral component of the live performance or as an end product—will need to take these factors into account to achieve the best results. This section deals with two problems that can be mitigated with a more or less unified approach. The first problem is the difference between the requirements of lighting for the live audience and lighting for the camera, and the second problem is integrating projected images into a live performance. Both problems are addressed by making sure the lighting required by the captured image—whether that image is projected in real-time on stage or recorded for later viewing—is properly accounted for in the overall lighting plot of the production.

Lighting Basics and Implications for Lighting

The factors affecting lighting for video vs. lighting for live audiences all relate to the contrast ratios (difference between light and dark) that film, video, and the human eye can each detect, and the effect that this has on color representation. A good approximation is that the human eye can detect contrast ratios of 2000:1, film can detect ratios of 200:1, and video can detect ratios of 20:1. Furthermore, these ratios represent maximum sensitivities. For important shots such as facial close-ups, an even more careful approach is desirable, with the difference between key and fill lights being no more than 2:1. Otherwise, too much of the image will be near the threshold of the tonal range of the video medium, with fine details in light and dark areas appearing as undifferentiated fields of white and black. In these cases, the production team must decide what elements of the on-stage event are the most important for screen audiences to experience; something will be lost, the team must decide what that will be. For example, live audiences can discern subtleties of texture and tone in pale costumes against a moody, dimly-lit background, but a camera will have trouble capturing such nuance. The team must decide where in the range of light and dark the most salient details occur, and instruct the camera operators to adjust the camera settings such that it is sensitive in this area. The point is especially important for recordings sent out as files over computing networks, as the compression involved with getting video into streamable and/or easily downloadable forms exacerbates the starkness of an image's contrast, further reducing detail in light and dark portions of the frame.

Color is related to contrast in that any given camera's representation of chroma—the color of light—will vary with changes in luminance—light's intensity. (Contrast is the ratio of the amount of luminance in one area of an image as compared to the amount of luminance in another area.) The chroma of a light, its hue and saturation, is not the same as its color temperature, which is a measure of how red or blue it looks. (Color temperature is discussed further below.) How a camera will read color at various luminance levels is a choice of the manufacturer. For example, an early popular digital camera (the VX 1000) suppressed greens at low light intensities, favoring the reds in an image. One reason that some cameras tend to favor reds is that the longer wavelengths in red light diminish detail, and are thus forgiving to images of faces. In effect, these video cameras were optimized to portray human faces. However, each make of camera is different, and even multiple cameras of the same model will need to be calibrated to ensure that their colors are matched.

As certain objects are heated, they glow; producing light as well as heat. Color temperature represents the heat to which such an object would need to be heated to emanate light of that 'color'.

Measured using the Kelvin scale, redder light is produced at a lower temperature, and bluer light at a higher temperature. Below is a table of approximate temperatures for various light sources.

Light Source	**Approx. Color Temp.**
Candle light	2200 K
Household incandescent light	2500-3000 K
Sunset/sunrise	3000 K
Studio light	3200-3400 K
Standard office fluorescent light	3500 K
Early morning/late afternoon	4400 K
Light from monitors/TV screens	6600 K
Clear blue sky at midday	5500 – 10,000 K

The human eye can notice difference in color temperature in increments of around 200 K. However, the eye does not refer to past impressions of light to determine relative color temperature. When there is a single light source, the eye adapts to it, seeing it as 'white' regardless of its actual temperature (unless it is specifically colored, as with a gel). Usually, the color temperature of light only becomes apparent when there are multiple light sources, each reflecting light of different spectral qualities and casting shadows of different hues.

While the human eye will notice these properties, it is relatively graceful in the way it handles this apparent discrepancy. It is much more forgiving in this regard than video; images with lights of varying color temperatures will tend to look multi-colored and unnatural in video. Video cameras do not make the automatic adjustment that the human eye does; camera operators must adjust white balance settings by hand. This adjustment ensures that the camera reads the proper light source as 'white', and uses that as the basis on which to judge the color temperature of any other light sources present. Although many cameras have a feature called 'auto white balance', this feature should never be used. It is designed to mimic the eye's ability to adapt to changing lighting conditions, and in theory it adjusts the sensitivities of the camera to ensure that light that appears white in one moment will maintain its appearance throughout the shoot. However, the light used as a reference is based on arbitrary 'standard' conditions, which almost certainly will not match the conditions on stage. Moreover, because auto white balance is designed to maintain consistency in the face of changing lighting conditions, cameras using it will attempt to compensate for light cues. The result is that over the course of a capture, objects will appear to change color as the camera 'adapts' to the changing lighting by varying the color temperature it reads as white light.

The different cultures of film/video and theatre are made apparent in the ways each sees and deals with lights of multiple color temperatures. In theatre, having multiple light colors is dramatic; in video it is unnatural. While theatrical lighting conventions require bold choices to reach the back of the house, video requires lighting that interferes as little as possible with the subject's natural look. In video, unless a special effect is desired (such as using blue light to highlight the contrast between a cozy interior and moonlight), the presence of lights at different color temperatures looks odd. Moreover each industry achieves a desired color representation in a different manner. In film and video, color representation is generally altered by changing the subject's coloration (e.g. through makeup). In theatre, it is generally altered by changing the color of the incident light on the subject (e.g. through gels). While film and video lighting will use filters and gels, these are often intended as corrective measures, not as ends in and of themselves.

One way to manage lighting color and contrast for video close-ups is through traditional video three point lighting, consisting of key, fill, and back lights. The key light is the assumed and obvious light source, whereas the fill isn't so much a second light source as it is a shadow softener. Therefore the fill light must be of a color and intensity to avoid calling unwanted attention to itself. Otherwise, the fill light will emphasize the unnaturalness mentioned above, not what it is intended to illuminate. Back lighting outlines the perimeter of whatever it hits, separating subjects from their backgrounds. While human vision, being binocular, doesn't need this effect in order to see depth, the camera image is flat. The bright outline imparted by back lighting allows the camera to place subjects in space, giving them back their three-dimensionality.

The impact of multiple light sources of varying color temperatures is particularly important when a performance includes projected images, whether of previously recorded material or of real-time simulcasts of the live events on stage. Projectors tend toward bluer color temperatures; this strong blue light can wreak havoc with a pre-determined lighting design if it is not taken into account. The projected image is a non-trivial light source in and of itself, which reflects (backlights) everything else on stage, giving them very blue shadows. Short of changing the color temperature of the projector bulb—which is not always possible, especially if the projector is not under the control of the production team—the best way to handle this is to plan for it in the lighting design. For example, the lighting designer can use the projector's bluer white light as an 'absolute' white, and then choose the rest of the colors in the plot to complement that standard (instead of using an unfiltered theatrical light as a reference white). This and other kinds of pre-planning are especially helpful when projecting close-ups of live onstage happenings. For example, while down-ward projecting lights and dramatic makeup may serve the purpose of lighting for the live audience, these effects need to be carefully considered when paired with video screens. Light from above gives subjects' faces unflattering (and perhaps unintentional) eyebrow shadows, and makeup that appears subtle when viewed by distant live audience members appears clownish when seen in portrait close up.

Summary Recommendations for Integrating Captured Images into Live Performance

The main concern should be making sure that the different contrast capabilities of video and the human eye are taken into account.

A) 'Look before you light!'

- If cameras/recording are going to be a part of the production, bring them in early in the process —preferably before lighting design is started, and definitely before it is complete.
- Have a real production monitor, not a TV screen, on hand and use it when setting the lighting; look at it, and not at the stage.
- Often, a less radical lighting treatment is necessary for video than may be desired solely for a live audience.

B) Decide what are the essential elements of any given performance, and light those for video, so that the camera can capture those well and their impact transfers to the recording.

- Decide where in the tonal range (light or dark) the most interesting moments happen; either use much lower contrast ratios for those moments or be prepared to lose elements at the opposite end of the range.

C) For productions that include projection, ensure that the intensity and color of the light on live subjects is matched to the intensity and color of the projected images.

In essence, we recommend lighting the production to emphasize its critical moments. More to the point, these moments should be lighted as video moments, though the stage as a whole may be lit for theatre. Lighting key moments for video helps fulfill the need to preserve the original live artistic expression through the video medium to the end user, who will be viewing the production over a network on a computer monitor. These three different media employ correspondingly different idioms; the capture of a performance experience onto video may best be thought of as a translation of the original work, not as a transliteration. Just as a good translation is an interpretation that seeks to preserve a work's essential impact over its literal execution, those designing the capture of a live performance must attend to the requirements of the video medium if the impact of the original is to be conveyed to end users.

Overall, production teams must remember the need to light for both the camera and the live audience; the fact that the camera will see things differently cannot be emphasized enough. All that having been said, it bears repeating that recent advances in non-linear editing mean that now there are amazing things production teams can do in postproduction. For example, digital color grading allows fine adjustments to be made to the color balance, saturation, brightness, and general ‘look and feel’ of an image; some packages allow colorists and cinematographers to extend this control not just to individual frames, but to selected objects within a frame.

Video

Camcorder Features and Functionality by Format

The landscape of digital video formats, features, and models is under constant transformation. Continuous improvements in technology, as well as the pressures of the electronics market, lead to very rapid product lifecycles. This constant turnover can cause confusion; moreover this confusion can be greatly magnified for users who are not familiar with video recording technology, as many of the desirable features of digital equipment are similar to those of traditional analogue video recorders.

The table below presents some of the options and features available within a few specific digital video formats. Due to the rapid product cycle mentioned above, we suggest you look for features instead of for brands and/or models. While the specifics of features will change, they are somewhat more stable than models. Among the many options, Digi-Beta, DVCAM, and MiniDV are by far the most prevalent formats among projects known of by the Performance Archive & Retrieval Working Group. Other formats (both emerging formats like DVD-RAM and present-day niche markets such as Digital-8) are currently much less popular than these three. Unfortunately, in many cases, there is a tight relationship between the format chosen and the brands that support it. For example, Digi-Beta, and to a lesser degree DVCAM, are proprietary formats from Sony. Comparable to the Sony format is DVCPRO, Panasonic's proprietary system. In the case of DVCAM, other manufacturers have started to make cameras compatible with the format, but so far Digi-Beta recorders and/or cameras appear to be available only from Sony.

The data in this table was gathered from the specifications on multiple vendor and retail websites, and as such is approximate, not specific, in its accuracy. Where ranges are given, they represent the variety of values found for that piece of information. Where data is lacking, specific information on that item could not be found.

Camcorder Features and Functionality by Format

	Amateur (MiniDV)	**Prosumer (DVCAM/DVCPRO)**	**Professional (Digi-Beta)**
Overview [Note: Manufacturers often separate the specs for the camera, lens, and recorder.] [Note: definitions appearing in quotes are from: http://www.gearpreview.com/]	"MiniDV is consumer DV system backed by manufacturers such as Sony, Philips, Thomson, Hitachi, Matsushita (Panasonic) and others. MiniDV has great picture quality for the price, so it is getting popular to independent filmmakers and home users."	Like DVCPRO, Panasonic's comparable proprietary system, "DVCAM is a professional DV system from Sony used for industrial, ENG [electronic news gathering] and EFP [electronic field production] purposes."	"Digital substitute to Betacam SP format. Introduced by Sony in 1993, uses similar half-inch cassettes. Digital Betacam is the first component digital ENG (electronic news gathering) format. Digital Betacam units play back analogue Beta SP tapes, but do not record."
Aspect Ratio (4:3=TV, 16:9=film: High-level cameras will generally have both aspect ratios native to the system, while medium-level cameras generally will have either the 4:3	Generally 4:3. Some cameras are switchable through a chip.	Generally switchable through a chip. (Cameras with 16:9 native will tend to be more expensive than cameras with 4:3	Newer models support 16:9 native

	Amateur (MiniDV)	**Prosumer (DVCAM/DVCPRO)**	**Professional (Digi-Beta)**
or the 16:9 aspect ratio native, and will "switch" to the other by forcing the conversion through a chip. This leads to lower resolution than shooting in the native resolution.)		native.)	
Audio Mode(s) (Word length in bits, sampling frequency in kHz.)	Generally 12-16 bits, 24-48 kHz.	2-channel recording mode (sampling frequency of 48kHz/16bit) and/or 4-channel recording mode (sampling frequency of 32kHz/12bit).	48 kHz
Battery Life (But extras can always be swapped in.)	2-7.5 hours	Up to 8 hours	2-3 hours
Built-In Lighting	Generally no.	Sometimes available as an optional add-on.	Sometimes available as an optional add-on.
CCD Pixels (In megapixels. A CCD—Charge Coupled Device—is a camera's capture device. A camera with 1 CCD captures an entire image in one pass, while 3-CCD cameras use a separate CCD for each color channel.)	1 CCD: .8-1.5 megapixels. 3 CCDs: .25-.4 megapixels.	3 CCDs, .38-.6 megapixels each.	3 CCDs, .35-.52 megapixels each.
Color View Finder	Generally, yes.	Not always.	Usually not.
Compression Ratio	5:1	5:1	2:1
Frame Rates (30 fps= Video, 24 fps= Film. A camera that can shoot both makes film transfer much smoother.)	A few cameras can handle both.	A few cameras can handle both.	New models tend to offer both with 24P (24 frames progressive scan now most popular).
Image Stabilization	Available, some using optic stabilization.	Available, some using optic stabilization.	Available, some using optic stabilization.
Interchangeable/Standard-Sized Lenses	Few models offer this feature.	Few models offer this feature, one model offers C-mount lens options.	Most models offer a variety of lens options. Some offer 35mm film optics.
Lux Rating	2-15 lux at low	.11-2 lux	.15-.2 lux

	Amateur (MiniDV)	**Prosumer (DVCAM/DVCPRO)**	**Professional (Digi-Beta)**
(Lower is better, camera specs give a wide range of values.)	shutter speeds. 100+ lux recommended.		
Macro Focus	Depends on lens.	Depends on lens.	Depends on lens.
Optical Zoom Rating	10X-22X.	Wide range of options.	Wide range of options.
Price Range (In US dollars.)	$400-3,000	$3,000-10,000	$10,000-70,000 (high definition cameras and lenses may cost even more)
Recording Length	40 to 120 minutes, depending upon camera and DV cassette and selected recording speed.	Supports cassettes of standard size (up to 148 minutes of recording). Some also support MiniDV size tapes (up to 40 minutes of recording).	Cassettes of up to 40 minutes.
Recording Modes/Tape Speeds (Extended vs. Normal Play; Alternate Recording Media, etc.)	Approx. 18.8 mm/sec (SP), 12.6 mm/sec (LP).	Approx. 28.2-28.8 mm/sec.	Approx. 96.7 mm/sec
Resolution (In horizontal lines)	525-720 lines, when applicable.	525-800 lines.	600-850 lines.
Shutter Speed	Min range ¼ - 1/24. Max range 1/2,000 - 1/60,000 second. (High end rarely available at this price point.)	Min range ¼ - 1/50. Max range 1/2,000 - 1/10,000 second.	Min range 1/60 – 1/100. Max 1/2000 second.
Size of LCD Monitor	2.5” x 3.5”.	2.5” x 3.0”.	1.5” x 2.0” CRT viewfinder size; usually no LCD monitors on these camcorders. LCD optional viewfinders up to 5” available.
Time Lapse	A few cameras are capable of time lapse / interval recording.	A few cameras are capable of time lapse / interval recording.	
Type of External Mic Input (Balanced vs. Unbalanced.)	Unbalanced, adapters available for balanced input.	Balanced.	Balanced.

	Amateur (MiniDV)	Prosumer (DVCAM/DVCPRO)	Professional (Digi-Beta)
Type of Image Scan (Interlace vs. Progressive)	Cameras are fairly evenly split between interlace and progressive scan; a few cameras can handle both.	Most cameras can handle both.	Most cameras can handle both.
Type of Computer Connectivity (IEEE 1394 [i.LINK/Firewire interface], USB, etc.)	USB, IEEE 1394.	USB, IEEE 1394.	
Type of Time Coding and Sync	If present, Drop Frame or SMPTE.	SMPTE. (Sometimes can be genlocked to time-code sync multiple cameras.)	BNC. (Can be genlocked to time-code sync multiple cameras.)
Variable Speed Zoom	Sometimes.	Usually.	Always.
Video Connectivity—Analog In/Out	Generally, yes.		Generally, yes.
Weight (Camera-only range/fully-equipped range.)	.5-3.4 lbs / 2-6.5 lb.	5-10 lbs / 12-14.5 lbs	11 lbs / 15 lbs

More information about digital video capture is available at the links below:

- http://archive.sourcemagazine.com/archive/900/feature5.asp A good consumer-level introduction to digital video cameras, capture, and editing. Includes a short glossary and an equipment requirements list.
- http://www.videoletter.org/suggest/videng.htm A very basic introduction to the digital video production process is available at "The Production of a Videoletter: Rudiments of Production." It is an English translation of an article describing the equipment needed for and steps in the process of consumer-level digital video production. While the translation is awkward, the article gives a good introduction to the entire process.
- http://videosystems.com/buyers_guide/index.htm *Video Systems Magazine* buyers guide listing hundreds of video capture and editing solutions and vendors.
- http://www.dv.com/magazine/ "Since 1993, *DV* magazine has served the information needs of professionals involved in the production, postproduction and delivery of digital video. Written and produced by experts in the field, *DV* provides objective, hard-hitting, in depth product information."
- http://videoexpert.home.att.net/artic3/262hdvr.htm Detailed article about available high definition recording formats.
- http://www.jvc-victor.co.jp/english/press/2003/gr-hd1.html Newly-released consumer high definition camera from JVC. Using 1/3 inch-type 1.18 million pixel progressive scan CCD and JVC proprietary processing, the new camera records and plays back 750/30p (1280x720/30p viewable) digital high-definition and 525p progressive wide images to mini DV tape.

- http://www.dps.com/pdfs/dps_white_papers/High_Definition_Video_1-0.pdf Link to a PDF article defining high-definition technologies. Includes a discussion of high definition standards.
- http://www.researchchannel.org/ High definition video over the Internet from ResearchChannel, a consortium of Internet2 connected institutions. This web site contains a wealth of valuable information about recording, distributing and archiving high definition content.

Please note that very high-end digital video cameras, e.g. HDTV cameras, are much more expensive and complex than the options in the table above. Prices are in the $100,000 range, with $30,000-$50,000 of that being for the recorder alone, not including camera. Teams for which HDTV is a viable option are likely to be situated within parent institutions willing and able to invest in the people necessary to run the technology as well as in the technology itself. These teams should defer to their on-site digital video experts for assistance with any questions beyond what the sources above can answer.

Multiple Camera Options

Typical live recordings of complex events involve multiple cameras, usually under the control of a director. The multiple video feeds are routed through a production switcher to a transmitter and/or video recorder. Sporting events (golf, racing, tennis, football, basketball, etc.) offer the most complex set of events because much of the action is unscripted. Concerts, theatre events, and dance performances may follow a script or unscripted format. In most cases, a composite final tape is the recorded result. Isolated cameras may be recorded on separate tapes to provide editing options or in the case of DVD formats, multiple camera tracks available as optional viewing paths. As mentioned earlier, the cameras are either gen-locked together or digitally synced to permit smooth mixing of images or clean switches between view sources. With today's non-linear editing systems it is relatively easy to sync up multiple camera feeds to isolated or mixed audio sources in the post-production process. Sound and video tracks may be stretched or compacted to perfectly sync sound with motion.

Audio

Some events, such as concerts, can be usefully archived as audio recordings. Others events are more significantly visual and are best archived as video recordings. But even video recordings have an audio aspect. These notes are useful for both situations.

For some people, audio production is a lifelong journey of theory and applied craft that requires both the mastery of complex technology and artistic sensitivity in making aesthetic decisions. After a point there is simply no substitute for the employment of skilled recording engineers and producers. But it is also true that worthy performance archive efforts can be executed with limited means.

The intention here is not to turn you into a sound recording expert overnight. Rather the intention is to orient non-experts by providing a broad view of the available options, to flag the options, which will likely require the help of audio experts, and to note some simple steps that can significantly improve the recordings made by non-professionals. Finally, to provide additional details that go beyond the scope of this document, a number of related web sites are suggested.

In the following sections we consider both audio-only recordings and the use of audio in video. And for both situations we consider three scenarios. In the simplest scenario, two microphones are used to make a 2-channel stereo recording. In the most complicated scenario a number of microphones are used to record each instrument and/or voice to its own track on a multi-track recorder. Long after the performance is over, this multi-track recording is mixed down to a stereo recording. The middle scenario uses a number of microphones, but the signals are mixed down to a stereo recording in real-time during the performance, thus eliminating the need for a multi-track recorder and mixing session after the performance. The use of multiple microphones and multiple tracks gives the producer more options and finer control over the product, however this control comes at the expense of greater time and technical complexity.

Microphones

The value of any sound recording begins with microphone quality and technique. Proper use begins with understanding which type of microphone is right for the job. Some microphones are better for high noise levels, while others are better for low noise situations. Microphones also vary in frequency response, meaning they may be more sensitive to bass tones or may color sound to emphasize the mid-range or upper harmonics. Omni-directional microphones are equally sensitive in every direction. Others may be bi-directional (sensitive to both front and back but not to the side), and others such as so-called cardioid mics are directional, or like the shotgun mic, highly directional. Here is a good primer on microphones and their use:

http://arts.ucsc.edu/EMS/Music/tech_background/TE-20/teces_20.html

The selection and placement of microphones in a complex production where, for example, every player or instrument section has its own mic, is something better left to professional recording engineers. Simple productions of good quality, however, can be achieved by enthusiastic non-professionals, and suggestions to that end appear in the section entitled, “Tips and Techniques for Better Sound.”

Recording Audio for Audio-Only Archives

While there are a number of nascent consumer technologies for multi-channel surround sound, the vast majority of sound recordings are still delivered in a 2-channel stereo format. But even if the final recording consists of two channels, intermediate recordings may exploit many more. While the variations are countless, here we present three scenarios.

Scenario #1: Direct 2-Channel Recording Perhaps the simplest method, two microphones are connected to a pre-amp or mixer that raises the signal from microphone level to line level and it, in turn, is connected to a stereo recording device. The typical and best device to use for simple stereo recording is a DAT (Digital Audio Tape) deck. The digital uncompressed 16-bit, 44.1/48-kHz sampling rate signal matches the response of the human auditory system. Other recorders may introduce some degree of noise and distortion. Traditional analog cassette decks and all but the best (now archaic) analog reel-to-reel devices will add noise and distortion compared to DAT. Less expensive consumer digital formats such as the mini-disc or MP3 devices will at times introduce audible artifacts related to data compression.

Recording stereo uncompressed audio directly to disk, or indeed to a portable computer, has in recent years become a viable alternative. There are, however, some disadvantages. Users of dedicated disk recorders may find that they are always low on available space, and will have to quickly move their files to a less expensive digital medium anyway. And portable computers are, in a sense, over-engineered for such a simple task, and yet are far more likely to crash or otherwise fail than the simpler DAT.

The position and quality of the mics, and the sound of the hall will mostly determine the sound quality of recordings made with a single pair of microphones. Experimentation is the key, but a good starting point is two cardioid mics with their pickup elements nearly touching, suspended and centered in front and above the audience, with one mic pointed about 45 degrees to the left and the other at the same angle to the right. Here is an in-depth FAQ for those recording directly to DAT using two microphones:

http://www.josephson.com/mic-faq.html

Scenario #2: Multiple Microphone 2-Channel Recording Similar to scenario #1 above, this technique records to a stereo device, such as a DAT. The difference is that a larger number of microphones are used and connected to an audio mixer. This allows the recording engineer, in real time, to adjust the relative balance of the instruments in a way independent of what is heard by the audience in the room. In addition, because a number of microphones are used they can be distributed and placed close to the sound sources. The stereo pair in the previous scenario will tend to record everything, including audience noises, doors opening, air conditioning sound, etc. By placing a larger number of mics close to the sound sources, extraneous noises can be diminished, and different specialized microphones can be matched to the given sound source. In addition, electronic sound sources used in the performance can be directly connected to the mixing board.

Scenario #3: Multiple Microphone, Multiple Channel Recording Similar to scenario #2, this setup uses multiple microphones, but rather than immediately mixing those sound sources to a stereo mix, the individual sound sources are recorded to individual tracks. Then, at some later time, the multi-track recording can be mixed down to a final stereo mix. The advantages here include:

1) not having to get the mix right the first, and only, try

2) being able to equalize individual tracks to apply control over timbre and tone

3) being able to mix through high-quality studio monitors without hearing the ambient sound of the live acoustic sources in the room

Here is a home recording primer that provides some useful information for scenarios #2 and #3:
http://www.recordingeq.com/EQ/req0201/feature.html

For scenario #3 popular tape-based, multi-track digital recorders include the Alesis ADAT series:
http://www.alesis.com/products/recording/index.htm

And the DA series from TASCAM such as the DA88:
http://www.tascam.com/products/dtrs/da88/index.php

In addition there are a host of options for direct to disk multi-track recording including both computer-based and dedicated hardware options. The comments above regarding stereo hard disk recording applies to these devices as well.

Systems such as the ADAT and DA88 can record up to eight simultaneous tracks of audio. If more tracks are needed, multiple units can be interconnected to provide control (play, record, stop, etc.), timecode (allowing random access based on elapsed time), and word-clock synchronization (so that each device produces samples in exact lock step). The devices then essentially act as a single large recording device.

Audio-Only Choices and Tradeoffs

It is entirely possible to create a satisfying and commercially viable recording with a single DAT, a pair of microphones, and simple pre-amp (or mixer) via scenario #1. The dominating factors will be the "sound" of the hall and the quality and placement of the microphones. And while even this simple scheme will benefit from the assistance of a professional recording engineer, it is also within the reach of careful amateurs.

Scenarios #2 and #3 will require experienced help, but properly done should provide better results as specialized microphones can be assigned to specific sound sources, the sound of the hall can be controlled for greater or lesser effect, and the overall mix of the instruments and voices can be finely controlled and adjusted.

Recording Audio for Video Archives

Recording audio as part of a video project is similar to the above three scenarios. The primary additional challenge is maintaining synchronization between the picture and the sound. This is easy to do by simply using the video camcorder to record both picture and sound. But, as in the audio-only scenarios noted above, a more complex scheme using multiple cameras and audio recorders offers greater control and more creative options in post-production.

Scenario #1: Direct 2-Channel Recording This is what the typical consumer does with a camcorder using the built-in microphone. However, the sound quality of such recordings can be greatly enhanced by using external microphones, balanced cables, wind screens and so on. All of the notes for the audio-only scenario #1 apply here, except a camcorder rather than a DAT is used to record the sound. Additional tips and techniques are in a following section.

Scenario #2: Multiple Microphone 2-Channel Recording Similar to scenario #2 above, this allows using a number of microphones that are mixed in real time, and all the advantages that implies, and yet avoids synchronization problems by recording the mixed sound on the video tape. However, like the audio-only scenario #2, this requires getting the mix right in real-time at the time of the performance.

Scenario #3: Multiple Microphone, Multiple Channel Recording In this scenario, one or more devices are used to record the picture and one or more multi-track decks are used to record the sound. Along with all the advantages noted above in the audio-only scenario #3, this also allows the optional re-recording of selected audio aspects of the performance.

In the making of Hollywood films it is common to re-record dialog long after the field production is "in the can." In a process called "looping" actors restate their lines in a recording studio while watching the picture on a monitor. Additionally, sound effects and music are added after the fact. Practice varies widely for both technical and artistic reasons, but in some films (or in some individual scenes) little or no sound from the actual shoot will remain in the final cut of the film. Whether this is useful, or perhaps even ethical, in documenting a live performance is open to question. It is worth noting, however, that many "live" musical recordings in commercial release include after-the-fact studio overdubs to fix bad notes, improve solos, and so on.

The separation of sound and picture recording introduces a host of synchronization problems. Used as independent devices, each video and audio recorder will rely upon it's own internal clock(s) to generate video frame rates and audio sample rates. Each will run at a slightly different rate. Once the video and audio tapes are gathered up and integrated for use in post-production, and work begins to edit various camera angles into a single linear program, and the audio is sweetened and mixed down to stereo, a number of sync related problems may be discovered. The most typical and troubling of these problems is that over time the picture and sound may drift out of synchronization.

It is possible to "wild sync" an audio recording and a separate video track in an editing package such as Final Cut Pro by simply sliding the audio relative to the video and using one's eyes and ears to match them up. Traditional filmmakers use a clapboard in production at the start of any scene to make this process easier. These techniques can work well where short segments are being edited together because the start of each segment provides an opportunity to resynchronize the materials. Unfortunately, documenting a performance may result in very long segments where drift will have enough time to make itself apparent.

The solution to most sync problems is to use a single external master clock that will synchronize all of the audio and video recorders at the time the performance is captured. Professional video recorders have a genlock input for a black burst signal (which is simply a composite video signal that displays a black picture) as well as a SMPTE timecode input. Both should be used. The genlock black burst assures that each device records each frame at the same time, and the latter assures that each simultaneous frame is labeled with the same hour, minute, second, and frame count. The black burst is also fed to a converter box that supplies sync signals for the audio devices. Audio devices will lock up to either a word clock signal or an AES/EBU (a.k.a. AES3) signal, and will also accept the same SMPTE timecode used for the video.

Unfortunately, inexpensive camcorders, and even fancy prosumer camcorders like the popular Canon XL1, do not offer a genlock input. This is a feature only found on comparatively expensive professional cameras and decks. Because of this and the technical complexity of the related synchronization problems, scenario #3 is really only viable where professional support is available.

As a footnote, if it is objectionable for the camera operators to be tethered to cables supplying synchronization signals, here is a wireless alternative.

http://www.ambient.de/clockit.html

Audio for Video Choices and Tradeoffs

The three video scenarios noted here parallel the audio-only scenarios in terms of complexity and tradeoffs. Scenario #1 will be dominated by the "sound" of the hall and the quality and placement of the microphones, and should be within the reach of careful amateurs. Such recordings will benefit greatly from the hints and techniques noted in the next section.

Scenario #2, and especially scenario #3, will require experienced professional help, but offer the promise of a very high quality final product with all the sonic benefits noted in the previous audio-only scenarios.

Additional Audio for Video Information

Here is a great technical resource for all matters regarding DV including related audio issues. It includes a good discussion of the complicated "locked vs. unlocked audio" controversy.
http://www.adamwilt.com/DV.html

NVision is a vendor that makes the kind of synchronization equipment noted above, and offers a number of free technical publications that are quite useful.
http://www.nvision1.com/Serv/RefLib/RefLIntro.asp

Finally, here is a nice glossary of signal types and summary of issues regarding audio and video synchronization.

http://www.sospubs.co.uk/sos/nov02/articles/studioinstallation1102.asp

Tips and Techniques for Better Sound

- Whenever possible don't use the built-in mic on a camcorder. They are often of questionable quality, overly compress the signal, and can pick up mechanical noise from the camera and operator. Use an external pair of mics and connect them to the inputs of the camcorder as noted here.
- Whenever possible use balanced (XLR connector) cables rather than unbalanced cables (which use two connector mini or 1/4" plugs). Balanced cables will resist picking up stray signals and noise.
- Camcorders other than high-end professional units, however, are not fitted with balanced audio connectors. A relatively inexpensive add-on XLR adapter can greatly improve the audio performance of consumer and prosumer camcorders, especially where long cable runs are involved. Here is an example of such an adapter: http://www.beachtek.com/dxa4.html
- When recording to a camcorder, use a pair of headphones to monitor the sound quality being recorded. Such headphones should not be the lightweight "walkman" type, but rather heavy ear enclosing headphones that block the acoustic sound in the room. Similar to the difference between the human eye and the camera lens, what the ear hears can be significantly different from what the camcorder hears. By monitoring with headphones one can quickly detect potential problems such as lavaliere mics rubbing against clothing, bad connections, signal levels that are too low or too high, etc.
- Where possible use lavaliere mics for actors and others with speaking parts. These are available as both wired and wireless devices.
- Place the microphone as close to the sound source as possible to improve the "presence" of the sound quality. Camera mounted microphones often result in a hollow, off-mic sound that can't be easily fixed in post production
- Use screens with close vocal mics to prevent popping. Electronic limiters and de-essers can also be of great help in improving vocal recordings. Microphones used outdoors should have foam windscreens to reduce related noise.
- Some microphones, such as those hand held with the use of a boom, will benefit from the use of shock mounts to prevent mechanical impacts from being turned into sound.
- When recording audio on a camcorder avoid using the automatic gain control (AGC) feature. AGC can overly limit the dynamics of the signal, and add strange sounds and artifacts. A better sounding recording will result if one makes the effort to manually adjusting levels.
- In general every audio input should be turned up enough to use the full dynamic range of the device, but should fall short of the point where the signal overdrives the input circuit resulting in distortion (i.e. the point where the signal "clips"). Pay close attention to any level meters the device may have as they will greatly assist in making this adjustment. Digital recorders in particular should not be overdriven, as distortion is harder to correct in them than in analog devices.

Appendices

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B) Notes on Other Relevant Guides

This 'current practice' guide is but one of many guides and recommendations for digitizing cultural heritage materials. Among others that we used for background information and as a model for this document are guides from the National Initiative for a Networked Cultural Heritage (NINCH), the Performing Arts Data Service (PADS), the Video Development Initiative (ViDe), and the Institute for Museum and Library Services (IMLS) [Introduction 5, 9, 12, 2]. Of these, the broadest are NINCH's *Guide to Good Practice in the Digital Representation and Management of Cultural Heritage Materials* [Introduction 6] and "A Framework of Guidance for Building Good Digital Collections" [Introduction 3] from IMLS. They look at all aspects of building digital collections, with recommendations ranging on levels from overall project management to specific practices, and they deal with the digitization of all sorts of original media. Both guides are in-depth resources, with links to further information.

More specialized are two guides from PADS in their "Guide to Good Practice" series: *Creating Digital Performance Resources* [Introduction 11] and *Creating Digital Audio Resources* [Introduction 10]. They focus specifically on the process for live media, and do not, for example, go into the digitization of text or still images. They are both created with a United Kingdom audience in mind, and as such deal with copyright and other intellectual property issues somewhat differently than this document.

ViDe's *Videoconferencing Cookbook* [Introduction 13] focuses on videoconferencing applications, hardware, and software. It was interesting to us as a model, especially for its form and for its section on broadcasting and archiving videoconferences via streaming video.

C) Authorship and Contact Information

Version 0.9 of this document was authored by the Performance Archive and Retrieval Working Group, jointly sponsored by Internet2 and the Coalition for Networked Information. The Working Group will be integrating additional comments in the future and releasing version 1.0 of the document as a result. Comments on this document should be directed to Ann Doyle, Working Group Chair and Internet2 Program Manager for Arts and Humanities Initiatives at adoyle@internet2.edu.

These guides to good practice are the product of the joint Internet2/CNI Performance Archive and Retrieval Working Group. Working Group members have made major and varied contributions to the guides, including but not limited to editing, reviewing, and drafting sections, as well as proposing initial outlines and topics for consideration and contributing general subject expertise.

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