The Right Stuff:

Building a Safe, Successful AV Equipment Solution for Archives and Museums

By

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Acknowledgements

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Abstract:

The prevalence of audio and video equipment in cultural heritage institutions continues to increase with time. Archives, museums, libraries, and galleries are building areas to view, digitize and preserve audio and video works. As their collections grow so does the need for the technologies to view these works. Stewarding collections of audiovisual (AV) works is relatively new for many cultural heritage institutions, and they will most certainly be adding more of them to their collections. Many of these organizations have great training and experience within conservation and preservation, however, up until this point they most likely have not learned the proper mechanics for constructing an AV system. If they have learned about these systems, it is only due to necessity. AV integration is a global industry that has many years of knowledge and resources from which to pull. This industry focuses on creating strong systems or technological backbones for institutions in order to aid in their communication and improve the functionality of the work being done. By bringing a different, foreign, perspective to archives, museums, libraries, and galleries, a new methodology for collection care can be fostered. Cultural heritage institutions may find answers to a lot of questions they are asking by turning to integration. In addition, the knowledge they find may help to keep their collections, as well as those working in the institutions, safe. This thesis will provide an overview of how archives and museums may find practical applications from the world of integration in addition to offering some basic knowledge towards the creation of an educational program.

Introduction

Every institution has different needs and resources when it comes to audiovisual (AV) setups. There is not one definitive way to build an AV setup, there are many, all of which are based on the needs of the institution building the system. There are, however, plenty of ways to build an AV setup that may cause damage to a collection, damage to the equipment, or harm to the staff using it. Between December 2022, and February of 2023, I reached out to people using AV materials across a variety of different institutions and interviewed them about their relationship to AV. I interviewed 12 individuals in total: Kelly Haydon, Maurice Schechter, Jochen Saueracker, Lia Kramer, Made Smith, Dave Rice, Catriona Schlosser, Michael Difillippo, Michael Grant, Michael Angeletti, Jonathan Farbowitz, and Greg Helmstetter.[1] I chose these individuals based on a variety of factors such as the institution they represented, their knowledge of AV (in an archival sense), their experience with racks/ rack building, and the different ways I believed they may be utilizing audiovisual equipment in their careers. I created a list of questions, slightly adjusted depending on the institution, to ascertain why one organization may have certain requirements that another may not. The basic questions may be found in the appendix of this paper. Throughout this thesis I will draw upon knowledge gleaned from these interviews as well as my background in AV and compare these to some well-known standards from the audiovisual integration industry. My goal is to examine a few key aspects of AV builds and offer cultural heritage institutions of all budgets some thoughts on how to get the most mileage of their build without causing any headaches to the care of their collections.

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[1] Dunbar_ IRB Study Number IRB-FY2023-7068

Background

In late 2022 assisting an archive with the task of digitizing a few hundred video tapes that had recently entered the collection. By the time I joined this project, the tapes had been organized in boxes and information written on the tapes captured in a spreadsheet. The workflow had become: clean the video deck, power it on, power on the time base corrector (TBC), insert the tape, calibrate to bars and tone on the TBC, capture the tape. I digitized for about half a day when one of the decks began having problems. The archivist and I took the deck out of the video rack for troubleshooting. Upon inspection of the deck, we discovered that when the deck is pulled out of the rack on its rails for head cleaning, one of the video cables can be ripped from the back of the machine. We realized the reason that the cable was violently removed during this process was that it was the exact length it needed to be to reach the time base corrector a few rack units above the deck. To further complicate the issue, the cable had not been properly dressed into the rack the last time this had happened and had been partially wrapped around the audio cable from the same deck, just a port below. When the video cable had been removed from of the deck, it also brought significant tension to the audio cable, causing the ground wire to loosen from its phoenix

Figure 1: Example of a Style of Phoenix Block (Dunbar, 2023)

block. To sum it up, due to improper installation procedures for this video deck, troubleshooting could create a vicious circle where the process would continually bring more issues to troubleshoot. This is one in a long line of issues affecting archives and museums across the United States.

Author Background

       To provide some context to how I am coming to this topic, it is important to discuss my background. I grew up in a home where tinkering was normal. I had a strong desire to figure out how anything and everything I could get my hands on worked. This was likely inspired by my father, Patrick, who has worked in Data Communications (DataCom) since before I was born. To provide a basic overview of what that is, DataCom is essentially the design, installation, and implementation of the infrastructure that allows devices to talk to other devices and people to talk to other people. My father works with integrators, organizations that design and manage AV systems, to install said infrastructure. Often this takes place in newly constructed buildings, but may also occur in older buildings as well. Pat runs everything from ethernet, to video and audio cables; installs sound systems; hangs display monitors; wires up racks; and does some low voltage electrical work, among many other things. I mention all of this about my father to paint a picture of how I grew up. When my father would need to perform maintenance or add things to our home, I was his assistant. From a young age, I would assist with fishing cables through the walls of our house, hang new TVs when the old ones would die, and even help to set up new sound bars or video players. As a colleague of mine once said to me, AV was in my blood. I went off to college in 2013 hoping to shoot movies, studying cinematography and all things technical in the film world at Temple University. Following this, I worked on sets for a short while before being drawn into the world I grew up in, AV. I have now worked in AV integration for over five years, first as a coordinator and then as a project manager, while also assisting with technical work as needed. I have numerous professional certifications from standards organizations such as OSHA (Occupational Safety and Health Association) and AVIXA

(Audiovisual and Integrated Experience Association) as well as certifications from a wide range

of manufacturers and organizations. I have worked on projects ranging in price from a few

thousand dollars to several million. I am not an expert in all aspects of AV and do not wish to

come off as such. However, I wanted to provide this background as it has influenced how I look

at AV setups in different cultural heritage institutions, as well as informed my questions for those

I interviewed for this thesis. I came to this paper with a bias when it comes to AV setups,

especially audiovisual racks. Through the research process, my eyes were opened, and I realized

that building and operating an AV installation in an archive or museum does not necessarily

equate to the same experience in some of the places I helped to build, such as theaters and office

spaces. I do think that both sides could learn something from each other when planning out an

AV system, regardless of how small or large it may be.

Terminology

What is AV?

In a literal sense, AV comes from the words Audio and Video and is a word used to

define a variety of media. For example, AV can refer to a piece of equipment, such as an

amplifier, that has audio capabilities within a system. AV can also refer to an organization whose

focus is on audio or video technology: an AV Company. AV can even refer to films, games,

television, and anything that utilizes audio and/or video as a key component. Within the context

of this paper, AV will refer to audio and video technology, specifically equipment and those who

use it. An AV rack is referring to a device that can hold AV equipment. These racks allow for

multiple devices to live together and can form the backbone of an AV system, or a system whose

primary purpose is to send or receive audio and video signals. Wiring, control, and

transformations are key components to an AV system. In general, the institutions I spoke with

utilize AV regarding artworks. These artworks may be audio specific, video specific, or exist as complex media work requiring an audio and/or video piece being played back through certain equipment or in a specific setup. A popular setup across institutions is digitization and playback stations. These setups allow for artworks to be examined and undergo quality control processes. These processes may allow for the works to be preserved or prepared for exhibition, in addition to being examined and studied to better understand the artwork and its preservation needs. A digitization station, on the other hand, allows for analog audio and video materials to be brought into a digital environment. For instance, a VHS tape from the 1980s can be played back on a videocassette recorder (VCR) or other tape playback decks and from there, the video can go through an AV setup consisting of a time base corrector and video scopes before finally hitting a computer with a capture card or software that allows the video to be digitized in the proper fashion.

Conventional AV terms can become tricky describing AV as it applies to artwork. Some artworks utilize the equipment for playback only; however, some use the equipment as a dedicated piece required for the artworks' conceptual or aesthetic integrity. Physically, items such as cables and speakers are still cables and speakers. Within the context of an artwork, however, these may have different names or meanings. For example, if an artwork is using AV equipment as a display piece it would not necessarily be handled in the same fashion as if it were a functional unit. There is a battle between form and function here. Sometimes AV equipment and cabling are used solely as sculptural pieces, and it does not matter if they function. So, in this case, the shell of the gear is what matters and not the mechanical or digital nature of it.

AV in Cultural Heritage Institutions

AV in the context of archives and museums may differ from AV in the context of construction or integration. In a new construction, the AV infrastructure is carefully planned in line with the building, or at least with the floor or location for which it is meant. Networking is often a huge component of new construction and may be the main requirement for a system. I do not mean networking in an information technology (IT) sense where the main goal is internet connection. Instead, I am discussing networking in terms of how a system is designed and how different rooms or different people may connect with each other to work on a project. There are both physical and logical topologies for this network planning. A physical topology is the actual cabling, switches, and other gear that makes up a network. A logical topology is a design or workflow of how data travels from point A to point B to point C and so on, without care for physical connections. These topologies are designed based on the needs of who will be using the system once built. An example of the networking I am referring to is a postproduction house. In a post house, the editor may need to send their edit to the colorist, or to the sound mixer, who might send their work to somebody else… resulting in multiple people working on the same project in a building. This requires effective communication and flow of information. Turning back to an archival setting, networking is important, but not the most important.

Networking in an archive is likely to be much smaller and constrained to a single location or group. Archives with larger budgets may connect to other systems, but they still may only have the need for a single rack or to be connected to a server that feeds people in one or two rooms. The scale and type of network required are very different. In addition, while a new construction may use previously owned equipment, most of the time the budgets are for new equipment and infrastructure. Depending on the archive's focus, the equipment being used and needed may no longer be manufactured. A budget here may include maintenance work, parts and

pieces, or purchasing a new-used piece of gear. Planning the AV installation is similar, yet still incredibly different. There is less focus on modern equipment in an archive because many of them are still working in the analog world.

AV Racks and Tools

Rack Components

This paper has a glossary (See page 68) of terms as a reference for some of the more technical terms, however it is important to go over the basics of AV racks and some of the more

Figure 2: Example of a Wooden Rack (Dunbar, 2023)

commonly used tools. An AV rack is an enclosure meant specifically to house different electronic equipment. These pieces of equipment, or gear, may be placed on a shelf or mounted to rails on the rack. These rack rails are pieces of metal that run the vertical length of the rack on both the left and right interior sides (but not necessarily in the front and back of the rack). They are lined with evenly spaced screw holes and are designated by rack units, or RUs for short. The standard rack unit is 1.75 inches high.[2] Equipment takes up space in the rack, measured in these rack units, and can be the size of a single RU or multiple. The standard width of an AV rack is 19 inches wide.[3] Racks can be made of various materials, such as wood or powder coated metal, and come in numerous styles and heights. Some racks are on wheels and can be mobile, while others are bolted into the floor. Some racks are short and are meant to fit under a table or in a cabinet, while others run from

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[2] Ciddor, Andy. CTS Certified Technology Specialist Exam Guide. 3rd ed. 149.: McGraw Hill, 2019.
[3] Ciddor, Andy. CTS Certified Technology Specialist Exam Guide. 3rd ed. 149.: McGraw Hill, 2019.

floor to ceiling. Yet regardless of their different makeups, they essentially all work the same and

house a grouping of AV electronics devices to create a system (or part of a system).

Figure 3: Example of a metal rack. (Dunbar, 2023)

Numerous options exist for rack accessories, each of which can change the dynamic of

how the rack operates. For example, racks can have doors on the front and/or back to lock

unwanted users out and protect the equipment. These doors may interrupt work if the

institution's flow relies on continuous and quick use of the equipment inside the rack. Doors

change how heat is vented from the rack, going through slits instead of being open to air. Doors,

however, can also assist in preventing dust and debris from entering and potentially clogging or

damaging equipment. The point here is that every item for a rack should be a planned decision

based around needs for how the rack and institution will operate together. One solution does not

fit all. Racks can have full shelves, half shelves, and shelves of different rack unit sizes. Some

shelves are vented to provide more airflow and others are totally solid to provide more support

for heavier objects. Heat is an important factor to consider when building a rack. Many pieces of

equipment have vents on the bottom or top, and sometimes both, to let the heat they are creating

escape. Warm air does not easily leave a rack and can cause equipment failure without proper

ventilation. Vents can be used to move air from the bottom of the rack upwards, thus forcing the

warm air to exit through the top and providing cooling to the equipment along the way.[4] When

designing a rack for airflow, it is important not to neglect the necessary workflow for the

institution. For example, if a piece of gear is used more often than others, it would be beneficial

for this device not to be at the bottom of the rack.[5] Drawers provide another option for storing

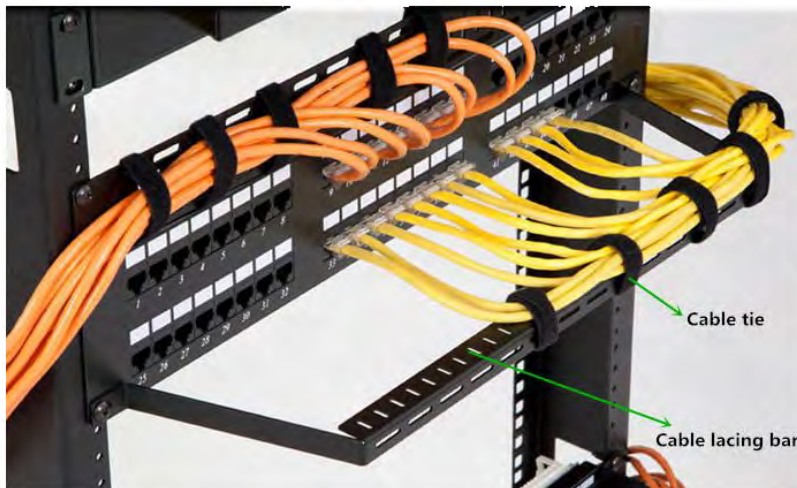removable equipment, spare parts, tools, or whatever is desired. Drawers, likewise, come in a

variety of shapes and sizes. There are various fans and power converters as well, however, one of the most important accoutrements for a rack is its cable management. I will discuss cable management in more detail later in the paper,

Figure 4: Example of Wire Management (Gui,2016)

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[4] Ciddor, Andy. CTS Certified Technology Specialist Exam Guide. 3rd ed. 150.: McGraw Hill, 2019.
[5] Maurice Schechter, interview by author, January 19, 2023.

however it is important to note here that institutions have a variety of options when it comes to

cable lacing. There are vertical lacing bars that run along the interior vertical length of the rack

and provide slits into which Velcro or cable ties can be inserted to secure cables or small

equipment. There are also lacing bars for racks that have rails on the back. These lacing bars

come in different dimensions but are all comprised of a solid bar that stretches across the rack for

items to be strapped to it. For patch cables (cables for a patch bay that are not permanently

affixed to equipment), claw style organizers or hook style organizers (aka D-rings) are available

where the cables can slide into place and hang.

Figure 5: Example of D-Rings (Legrand AV, 2023)   *Figure 6: Example of Claw (Markertek, 2023)*

Cabling

Cabling can be pre-manufactured or built by the institution with raw materials.

Fabricating cables can be beneficial for several reasons. Instead of trusting a manufacturer to

specify the best parts, you can ensure that you are using the cable, connectors, and testing

equipment that are up to your institution's standards. You can also cut the cables to the length

you need and not have any unnecessary slack, or a service loop that is much too long for what

could be needed. In addition, if working on a large-scale project, buying spools or boxes of

cables in bulk may be cheaper in the long run than buying pre-made cables. Cable, ends, and

tools can all be purchased from your local electrical or AV supply house.

Tools

Regarding tools, they are another key to AV. When building an audiovisual system, there

are some simple tools that will be useful in most situations. Scissors and flush cuts are important

parts of the technician's tool kit. Scissors are exactly what can be imagined; however, they differ

in an important way from flush cuts. When cutting cable, Velcro, or anything else, scissors cut

on a slight angle based on how their blades connect together. Flush cuts on the other hand are

designed to cut completely straight, or "flush." The ability to cut perfectly straight can be crucial if manufacturing your own cables. If a connector needs to be crimped on to bare wire, it will produce a better connection if the wire is flushed with it, as opposed to angled. This is especially important when terminating rj45 connectors for ethernet, as there are eight cables that go into the

Figure 7: Flush cuts and scissors (Dunbar, 2023)

connector end.

Screwdrivers are also essential; they can be used to help straighten cable for terminations, but more importantly they are needed to screw in screws. A screw gun or electronic screwdriver may save time and agony when building your AV setup. I recommend

Figure 8: Close up of flush cut blades (Dunbar, 2023)

looking for something antistatic if dealing with delicate or internal parts. A magnetic tip driver is

good for racking equipment. Something important to note is that when building an AV rack, one

should use a screw gun and not an impact driver/impact gun. Screw guns will nicely guide the

rack screws into place, whereas an impact gun presents more risk of stripping out the screw or

rack rail.

Wire strippers will be useful for taking the jacket off of cabling if completing your own

terminations. These have holes of various sizes meant to make life easier than stripping with

scissors, especially when it comes to smaller, thinner cables. They can be bought in a variety of

sizes, so it is important for an organization to purchase one based on its needs.

Figure 9: Wire Stripper   *Figure 10: Wire Stripper Sizes*

(Dunbar, 2023)   *(Dunbar, 2023)*

There are a variety of other tools that may be useful for an institution, but the last I will

focus on here is soldering irons. Similar in appearance to a screwdriver, this is an iron that heats

up to melt solder. Soldering is used in a variety of electronics applications, such as fabricating

XLR cables or attaching cables to circuit boards. Soldering irons have a wide variety of different

tips or bits meant for different tasks. These tips vary in terms of shape and size, so it is important

to determine which one best suits your needs. Another important tool is a label maker, of which

you can find two basic types: a wire labeler and a p-touch style labeler. Wire labelers create

labels that can wrap around a cable or other items that are not meant to be flat. A p-touch style

labeler creates a standard kind of label that you would find at home: a straight label meant to go

onto flat surfaces.

Transfer Stations vs Audiovisual Art

The information provided throughout this paper is meant to apply to AV setups, such as a

digitization station or viewing/playback station. There is a special case when dealing with AV in

cultural heritage institutions which is AV Art. I will not go into extreme detail about what

defines AV art, as that is outside the scope of this project; however, differentiating some of the

processes involved with preparing an artwork versus setting up an AV station will prevent some

confusion moving forward. In his book, *Still Life,* Fernando Dominguez Rubio writes that media

workstations:

> [C]an be seen as a geological cross-section of the main 'technological strata' that have
>
> accumulated over the last four decades… Its purpose is to serve as a 'time machine' of
>
> sorts that prevents artworks from becoming irretrievable by allowing them to move from
>
> obsolete environments of the past to working contemporary digital environments without
>
> needing to reproduce all the forms of expertise, practices and social relations that made
>
> them possible. A couple of clicks and your old U-matic video-art piece is migrated into a
>
> contemporary digital file.[6]

While AV artworks can rely on the work produced by media workstations, the equipment and

setup procedures required for each will be vastly different. By examining one example, Dara

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[6] Rubio, Fernando D. *Still Life Ecologies of the Modern Imagination at the Art Museum*. Chicago: University of
Chicago Press, 2020.

Birnbaum's "simultaneous projections: installation"[7] *Back Piece*, it is easier to see where the differences may be. *Back Piece*, at its most basic description, features a series of slides projected onto a canvas screen, dissolving between each other while two audio tracks play. At first thought, one might think that the process would be similar to a workstation: that is, set up the pieces in the way they connect to each other, or the way a manual or diagram details it. However, AV art requires an entirely different way of thinking and of building a system. A conservator and curator may go about preparing this artwork for installation in a variety of ways, all of which are up to the discretion of the institution. A media workstation here could potentially be used to produce digital copies of the slides, digitize the audio cassettes and create digital version of the audio, and create multiple levels of copies of said works (e.g. preservation, mezzanine, access, exhibition, etc.). However, if this video is part of an artwork that has specific requirements, more care and questioning might be needed before digitizing. In the instance of *Back Piece*, the artwork's physical pieces would rely on the effort produced by the media workstation for the content and potentially, the attempted reproduction of the experience that Birnbaum set out to create in 1975, the year of the work's creation. Dara Birnbaum describes the piece in part as follows:

> In the installation, the 'viewer' is presented with a contained space. She/he is enclosed between a wall (that mounts two slide projectors on a dissolve unit) and a hanging screen of canvas ... On the hanging screen is projected a series of slides that are a logical progression through the very space (in entirety) that the installation occupies… The pictures have been shot through an extreme wide-angle lens … Each slide dissolves immediately upon viewing into a slide that is thrown through overhead projection onto

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[7] Birnbaum, Dara. *Note(s): Work (ing) Process (es) RE: Concerns (That Take On/ Deal With)*. N.p.: Primary Information, 2021.

the screened platform behind the viewer… There are two audio tracks present (2 tapes in

small cassette cartridges); Each can be heard only if walked over to… A third tape may

be substituted for the other two/ or is to be used on a third channel (fading in and out of

the existing tapes). This is a 45-minute repetitive chorus[8].

The artist describes her work as a type of experience that has image elements as well as audio.

Choosing the equipment would be up to the team working on the artwork; however, more

decisions would have to be made about how the equipment would be presented. Birnbaum

provides a thorough, but not overly detailed, account of how to install the piece in her notes.

Birnbaum's notes are then interpreted by the individual or group tasked with collaborating to

install her artwork. With questions that challenge the setup of this artwork, the answers are more

complex than figuring out the best way to transfer a tape. Furthermore, while cabling in an AV

rack should be organized, that is not necessarily the case in the artwork. If the equipment being

used is from the original installation, the institution will not want to label it with p-touch labels,

for example. The type of cable management may differ based on artist direction or aesthetic

choice. Jochen Saueracker described to me a moment when working with his former teacher

where the instruction for arranging cables for an artwork was to drop the cable in a "certain

moment and at that moment, not to think about it."[9] The wiring, while functional, also took on a

sculptural role. In an instance like this, there could be no visible labeling, no wire ties, no strain

relief -- nothing that was not part of the artwork or artist's intention. Another important note is

that while AV equipment may be used in an artwork, it may have been used by people that did

not have professional experience with it. There are many artists creating AV artworks and using

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[8] Birnbaum, Dara. *Note(s): Work (ing) Process (es) RE: Concerns (That Take On/ Deal With)*. N.p.: Primary
Information, 2021
[9] Jochen Saueracker, interview by author, January 26, 2023.

the equipment differently than intended or setting it up in a fashion that disagrees with best

practices. Ultimately, AV artworks present a different set of issues and requirements entirely,

and my paper may only provide insight on a case-by-case basis. More research should be done

on how time-based media conservators and other stewards of artworks could use lessons from

the AV industry in their work, especially regarding safety. However, this is outside the scope of

this paper.

Factors Influencing AV System Builds

There are key differences in the requirements of different institutions, which I will break

down as such: budget, needs, politics, skills, and standards. Budget is the largest factor regarding

how an institution will go about their AV needs. As Greg Helmstetter summarized in our

interview, "I think that money and budget plays a huge role in what people can do on their AV

rack systems. And I mean, I've never worked for a system or for a company that's been like,

yeah, we can afford to do whatever we want. There's always some sort of budgetary

restriction."[10] Budget determines if equipment is bought or donated, as well as if the institution

will build themselves or hire a contractor. It determines what tools and accoutrements the

institution may have at their disposal; how cable organization is managed, whether there is a

power backup, and many more things. More urgently, the budget determines how long an

institution may have to deal with broken equipment, whether it is because they cannot afford a

part to fix it or the costs for a maintenance technician to repair it. Kelly Haydon mentioned a

situation where XFR Collective had a deck that was not completely broken, but was on borrowed

time. She lamented the fact that they did not have the budget to repair it and instead had to learn

to work around the limitations of the deck. Budget separates an independent outfit like XFR

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[10] Greg Helmstetter, interview by author, April 5, 2023.

Collective from a larger institution like the Library of Congress. It does not determine if one is better than the other, or the quality of their work, only the resources they have and perhaps the problems they face.

In addition, an AV system is often built on a need. Does the collection have U-matic tapes or is the focus on digitizing a VHS collection? Is the collection/artwork analog or digital? Does the system need this to connect to a larger asset management system or does it all go to the hard drive or server? Every institution has different needs and internal politics, and those will determine what they acquire to make their system work.

When I bring up politics, I am not referring to political affiliation, but rather the politics of the institution; the term "office politics" might make more sense here. These politics might involve something such as taking in a collection because it makes the institution look good, however, caring for it requires the purchasing of new equipment. The institution may have an agreement with an equipment vendor or manufacturer, or have a list of approved vendors which limits what can be bought and the cost of it. When I refer to skills, it is less complex of a meaning. The individuals working in an archive or museum are limited by the skills they have. If a museum is working on a complex media piece meant for exhibition, but it was coded in an old coding language or it is stored on a rarely seen piece of hardware, it may necessitate hiring an outside resource to work on it. Finally, standards may exist in an archive or museum. These standards may define materials or vendors used on the property. This is similar to politics, but slightly different because it could apply to a parent company that has an archive or museum under it rather than the archive or museum itself.

The combination of these needs in a specific situation could me the difference of using internal institutional resources to set up the system or hiring of outside contractors. Archives,

Museums, Galleries and Libraries would potentially have vastly different needs for an outside

contractor. Hiring a contractor to build a digitization and playback system is going to be different

than hiring a contractor who can assist with AV art. By the nature of what is being done,

artworks may require people with specific skills related to that artwork or to art in general,

whereas a contractor for digitization and playback may be more standard. To be more precise, an

AV integrator can set up a digitization rack, but a specialist may be required for artworks. The

world as of this thesis' writing is mostly digital, so choosing a contractor to assist in an analog

station may be more challenging than hiring any contractor, as they need to have those skills.

Returning to needs, it is important when hiring an outside party to build an AV system in which

there is specificity in requirements for how it should be built. How long should the service loops

be? Does the rack have room for future equipment? One should provide the information on what

decks will be necessary to fulfill the needs of the collection (if not providing the decks to the

contractor) and what the preferred output from the device is, if there are multiple (a composite

SDI output versus s-video, for instance). Dave Rice and Catriona Schlosser mentioned some

frustrating experiences they dealt with in the past where contractors would try to upsell

equipment or offer solutions that were lossy instead of lossless.[11] Talking with them reinforced

this idea of specificity by creating a list of needs and requirements.

Diversity of Participant Backgrounds

AV is learned through a wide variety of methods. Some people learn through classes,

offered in person or online. These courses are designed for a range of experience levels, from the

absolute beginner to the professional who is looking to brush up on some skills. Then there are

people who learn from books, such as a pocket guide or AV guidebook. These books are also

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[11] Catriona Schlosser, interview by author, February 6, 2023; Dave Rice, interview by author, February 6, 2023.

designed for a range of skillsets and come in a variety of shapes and sizes. Following this, some

people learn through online guides or manufacturer training. Both were designed by people who

use AV equipment for people who are starting out – those trying to learn about what AV is and

how to go about working with it. There are also individuals who learned by themselves out of

curiosity or by watching others work. The tinkerers and those who are inquisitive may figure out

how systems work by looking at them and playing around to see how or why a piece of gear

might work a certain way. Some individuals pursue formal education in college or university,

and may acquire technical certifications in addition to degrees. These are not the only ways that

people learn about AV, but a list of some of the more common methods.

Participants

The research participants I interviewed have diverse training. Kelly Haydon represents

XFR Collective, which is a smaller, more independent preservation outfit that is accomplishing

some amazing feats in low budget video preservation. Compare that to Jochen Saueracker, an

artist and engineer who has extensive experience in audiovisual/complex media art, most

famously with the works of Nam June Paik. I attempted to capture a wide range of different

experiences to synthesize a general view of how AV is used in archives and museums, in

addition to what resources may be useful. I reached out to Greg Helmstetter later in the process

than most because I thought his perspective would be important. Greg has worked in the AV

archival field as well as in AV for NYU, so he provided a unique perspective that others did not.
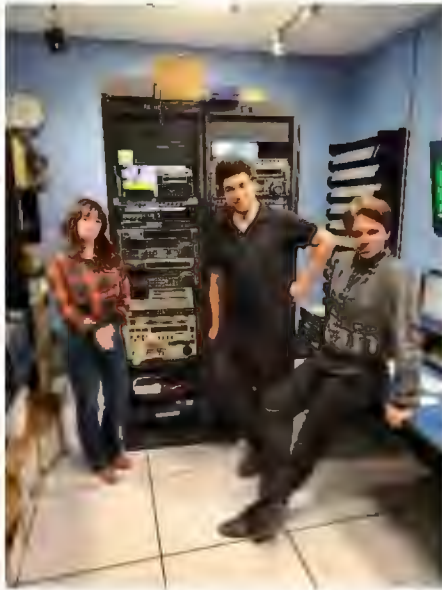
Figure 11: Catriona Schlosser, Michael Difilippo, Dave Rice

(Dunbar, 2023)

Figure 12: Jonathan Farbowitz

(Dunbar, 2023)

Throughout the interview process for this thesis, I asked each subject what education, if any, they

had in AV and how they got their start working in the field. The majority of those interviewed

revealed to me that their education was in a field either conservation related or adjacent to AV,

rather than AV itself. For example, there were several subjects who revealed an interest in

tinkering with technology when they were younger who now deal with audiovisual equipment in

their career. The other commonality that many of these subjects shared was that they learned by

going through requirements necessitated by a collection with which they were working. I believe

Jochen Saueracker summarized it best in his interview: "I must say I don't have any formal

technical education. I have a general interest in technical things. I have a background in the study

of physics, so there is a certain knowledge of how things might work. The other main learning

option was through job opportunities."[12] Regardless of their backgrounds, there existed an

inherent interest in technology or how different things worked, and that curiosity drove the

exploration later in their professional lives. The actual practical skill would come later. This

sentiment was echoed by a few individuals with Maurice Schechter believing electronics were in

his blood[13] and Michael Grant expressing an interest in technology and desire to figure out how

it worked:

> Yeah, I would say, in a not highly technical way, as a young person I didn't necessarily
>
> feel that I understood how any of it worked or necessarily even the capacity to understand
>
> how it worked, but I was interested, I was really interested in film, and I liked video. I
>
> wanted to get into film preservation specifically… Yes, I loved to take things apart.[14]

What I gleaned through these interviews was that curiosity is ultimately what drove their

eventual education. While they did not necessarily have a formal education in audiovisual setups,

they had an innate desire to figure out how technology worked and how it might be used. Each of

the interview subjects represented a well-educated individual with a level of higher education or

extensive working experience. They took their backgrounds and brought that to the field.

Training

There are a number of organizations and clubs that exist who offer a more formal style of

training in AV. Checking into local AV clubw to see if they have courses available is a great first

step. AVIXA offers courses online and in person and Legrand, one of the larger AV

manufacturers, offers online training as well through their Legrand AV portal. Online videos and

courses taught by manufacturers are a great way to get a more formal education in AV. Another

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[12] Jochen Saueracker, interview by author, January 26, 2023.
[13] Maurice Schechter, interview by author, January 19, 2023.
[14] Michael Grant, interview by author, February 1, 2023.

potential step is to go to a local technical school or community college and see if they offer any

continuing education courses. There are a variety of options available, so it is up to the learner's

preference as to what form works best for them.

<div align="center">**AV Standards**</div>

There are a number of standards from the AV industry that AV staff in cultural heritage

organizations might find helpful.

AVIXA

As both a standard and a safety practice, manufacturers outline recommended installation

setups in their documentation. This includes not only equipment, but also the racks themselves.

There are hundreds of manufacturers out there for these AV pieces, however I will focus here on

the standards organizations. The Audio Visual and Integrated Experience Association, or

AVIXA, is a nonprofit standards organization for the AV industry. Originally known as

InfoComm International, its name changed to AVIXA in 2017. AVIXA has standards that cover

everything from Rack Design (AVIXA F02.02:2020), to Cable Labeling (AVIXA

F501.01:2015), to Performance Verification (ANSI/INFOCOMM 10:2013), among many others.

AVIXA is also highly regarded by technology manufacturers and is mentioned in their

documentation, such as within an article published by Planar, which is a manufacturer of display

technologies. Their blog cites both ANSI (the American National Standards Institute) and

AVIXA as critical resources for designers, saying, "Planar encourages designers to familiarize

themselves with the AVIXA ANSI Standards and put them into practice. They represent ANSI's

essential requirements for openness, balance, consensus, and due process, so you know you can

rely on them."[15] I will talk about different types of labels in the documentation section later in

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[15] "Incorporating AVIXA & ANSI Audio Visual Standards into Your Projects." Planar. Last modified August 14, 2018.

this paper, but here I will discuss how AVIXA standardizes labels. They define two levels of

date within a label: Primary and Secondary. Section 3.6.2 and 3.6.3 of AVIXA's label standards

is as follows:

> Each cable shall have a unique identifier that shall be in alphanumeric format and
>
> readable without the aid of a machine. This identifier is determined by the schema
>
> identified in the project documentation. The numbering system should contain a
>
> consistent number of digits… Each cable shall have a unique identifier that shall be in
>
> alphanumeric format and readable without the aid of a machine. This identifier is
>
> determined by the schema identified in the project documentation. The numbering system
>
> should contain a consistent number of digits[16].

To break this down, each label should connect to documentation (discussed again later in this

thesis) such as a drawing or a cable schedule. Every cable will have a unique identifier, or a

unique number to the set, that can be read with the naked eye. As more cables are added, their

labels should follow the same scheme. This changes if the cable type changes; ethernet cables

will have different identifiers than SDI cables, for example. The secondary data is anything that

was not in the quotation above, such as source-to-destination identifier (though I personally find

these incredibly useful for troubleshooting), a bar code, or color-coded bands.

SMPTE

There are other standards organizations such as IEEE, or the Institute of Electrical and

Electronics Engineers, which is one of the largest associations for technical professionals. The

IEEE defines standards for much larger systems of technology; for example, IEEE 802 defines

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[16] Audiovisual and Integrated Experience Association. AVIXA F510.01:2015 Cable Labeling for Audiovisual
Systems. N.p.: AVIXA, 2015.

the standards for Local and Metropolitan Area Networks. While not AV specific, they are technology standards that may have some use if planning out an expansion of an archive or building a new archive or museum. The Society of Motion Picture and Television Engineers, or SMPTE, is an organization that defines standards across broadcasting, filmmaking, audio recording, and IT, among others. AVIXA defines rack builds and labeling, whereas SMPTE defines the signals going through those cables or important thresholds that pieces of gear may need to hit. For example, one of SMPTE's newer standard sets, SMPTE 2110, defines how digital media is sent over IP networks.[17] For an archive dealing with digital born content, SMPTE should be watched regularly. While 2110 may apply more to livestreaming and production, there are portions of it, such as ST 2110-22, that discuss video transporting in terms of compression; this may apply to digital archives, access files, and modern video art if it is meant to stream or have audience interaction. SMPTE 2110 is one of the newer standards, however many of their standards – even the most basic broadcast standards – are needed for tape digitization. Kelly Haydon provides an excellent example of the needs for standards, noting, "With video you also must worry about things like Broadcast standards, not knowing if you have a PAL tape and then putting a PAL tape in an NTSC deck and then not really knowing if what you're seeing is a problem with the tape or just a problem with the broadcast standard. You kind of must know more. I think you must know more standards."[18] The how's and why's of the many SMPTE standards are beyond the scope of this paper, however I encourage taking a deeper dive into their white papers if dealing with digital repositories or AV art.

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[17] Hippensteel, Phil. "What the AV Industry Can Learn From SMPTE 2110." AVNetwork. Last modified September 2, 2018. https://www.avnetwork.com/features/what-the-av-industry-can-learn-from-smpte-2110.

[18] Kelly Haydon, interview by author, January 17, 2023.

These standards are commonly used in new construction and AV integration, however archives, museums, and other cultural heritage organizations dealing with AV could learn a lot from them. The same goes for an archive or museum; while they may have similar needs, each institution will be different. Archives may have more need for digitization racks, whereas a museum will likely have more artworks. AVIXA's documentation standards would apply nicely to both situations and offer a robust way to capture technical information. SMPTE broadcast standards may be of use in an archive that lives within a university or television station where larger network connectivity may exist.

Institution Specific Standards

It is also important to note that organizations may have their own standards for how technology is to be implemented that may or may not include these previously mentioned standards. For example, the University of Houston has created a document on their *Audiovisual (AV) Design Standards* which specifies requirements for "Academic, Administrative, Auxiliary and Residential Spaces." The University's standards describe the physical requirements for equipment racks, cable management, and ventilation, among others. For instance, one such stipulation is that "rack design must allow for only a maximum of 75% fill to accommodate future growth. All racks should be enclosed. Racks installed in cabinetry should have a rear access, in the form of a lockable door."[19] While this clearly applies to multiple facilities throughout the University, an archive may be bound to these standards. These may be a hinderance, but also a benefit – in keeping with the University's policies, it may open an archive up to resources used for their non-archival AV and IT systems. While they have their own guidelines, they also reference AVIXA's standards throughout their document. Aside from the

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[19] UIT Classroom Technology, UIT Unified Communications and UIT Web Technologies. *Audiovisual (AV) Design Standards*. 1.04th ed. 2020.

general standards, they have also produced documentation for several potential platforms such as

AV/IT Infrastructure Guidelines for Courts and *AV/IT Infrastructure Guidelines for Higher*

Education. Though created for specific situations, they may still offer valuable information for

your institution if it falls under one of those organizational types.

<div align="center">**OSHA and Safety**</div>

OSHA

      While a lot of AV setup is ultimately up to those who are using it, there are certain

regulations that are important to follow. These regulations are sometimes standards meant to

keep people safe, while others are laws that need to be followed. OSHA, or the Occupational

Safety and Health Administration, is an organization created by the United States Congress in

1970. Part of the Department of Labor, this organization's mission is to ensure that people have a

safe and healthy workplace. OSHA rules do not cover everyone, but do cover most private sector

workers throughout the United States. Regardless of coverage, their knowledge and resources

provide a wealth of information to help make any workplace a better place.[20] OSHA has a wide

variety of standards, some of which apply to archives and museums, and others that may not.

The standards stay the same regardless of institution, however many places may not find need for

certain ones. Their website provides great information on personal protective equipment, or PPE,

which should apply to everyone. OSHA also offers training and certifications in a wide array of

topics. For instance, OSHA 10 and OSHA 30 are common courses/certification programs taught

to employees of a variety of industries. Per OSHA, "The 10-hour training program is intended

for level workers. The 30-hour training program is intended to provide workers with some safety

responsibility a greater depth and variety of training. All outreach training is intended to cover an

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[20] Visit their website at www.Osha.gov.

overview of the hazards a worker may encounter on a job site."[21] These trainings are often

inexpensive and can be valuable to employees of cultural heritage institutions when planning out

exhibits and restorations, or working with potentially hazardous materials. For example, OSHA

has an entire webpage dedicated to warehousing with links to the law, potential hazards and

solutions, as well as additional resources and training. While not every archive or museum has a

dedicated warehouse, the information may still apply to those institutions.

General Safety

In addition to OSHA, every state and even county will have different laws or regulations

in place for businesses, so it is important for archives and museums to pay attention to what is

required in their local area. Another important regulation to follow is the National Electrical

Code (NEC) which is created by the National Fire Protection Association (NFPA).[22] The NEC is

a voluntary, but widely adopted, code meant to standardize electrical installations to prevent

disaster. One such code that may apply to an archive or museum is the cable ratings. These are

standards related to cable construction and installation. Of these codes, the most widely seen, and

arguably, most important code is plenum versus non-plenum cable within certain spaces. Plenum

may be defined as "any hidden space is a plenum, even if not connected to ventilation or air

conditioning."[23] Sometimes it is more specifically defined as "a compartment or chamber in

which one or more air ducts are connected and that forms part of the air distribution system."[24]

This does not only include cabling that may live within an air duct, but also wherever the

chamber lives. Any cabling living above a drop ceiling that is not within conduit (piping), for

example, should be plenum. The interpretation may be slightly different depending on city or

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[21] "Program Overview." United States Department of Labor. https://www.osha.gov/training/outreach/overview.
[22] Visit their website at https://www.nfpa.org/.
[23] Lampen, Stephen. Audio/Video Cable Installer's Pocket Guide. 342.: McGraw Hill, 2002.
[24] NEC article 100, page 56.

county; however, it is essential that any cabling that lives in a plenum airspace must be plenum

rated. While the definition of plenum airspace will change slightly, this rule is important. Plenum

rated cable is built with a different cable jacket than standard, non-plenum rated cable is. Plenum

cable will burn differently should a fire break out and will be less toxic to those trying to get out

of the building. Per the National Electrical Code, Plenum Cables "have adequate fire-resistant

and low smoke-producing characteristics and are suitable for use in ducts, plenums, and other
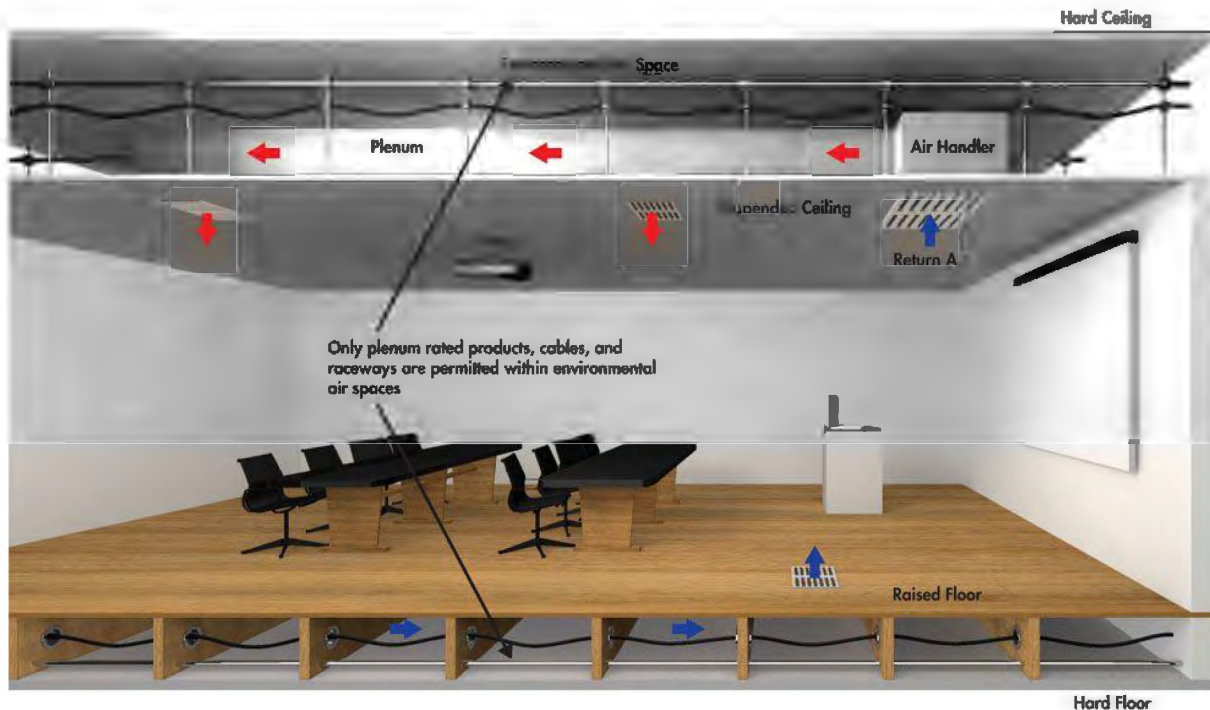
spaces used for environmental air."[25]

Figure 13: Plenum Airspace (King Electric, 2023)

The purpose of this code is strictly safety, as it can prevent further damage to people's lungs in

the event of a fire emergency. Another standard related to fire is cable color. Cables connected to

a fire alarm or fire suppression system are often red cables, so they stick out. While it is not

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[25] NEC article 100, page 56.

against the law to use red cable for other purposes, should this cabling connect to equipment

from the archive or near their equipment, it may be wise to keep the red fire system cable

separate or use different colors for cabling.

Figure 14: Variety of Fire Alarm Cable (Belden, 2023)

Safety is something that needs to be thought out, planned, and executed every day. No task

should come at the expense of your health. When building racks, it is important to ground them

so as not to cause electric shocks that can cause harm to workers or collectors. As Stephen

Lampen lays out:

> First, the rack itself might be grounded with a large wire running to a central ground
>
> point. Second, and most likely, conduit running in and out of the rack to deliver AC
>
> electrical power will provide ground for the equipment. Third, virtually all equipment has

a three-pin power cord. That third-round pin on the plug is connected internally to the

metal box or chassis of the equipment…. Because the equipment is grounded and the

equipment is mounted in a rack with metal screws, the rack is grounded. [26]

NEC article 250[27] covers the many different types of ground in a system, the focus being safety

first. There may also be other, non-safety related grounds in a system that could potentially

impede signal flow. These types of ground can be troubleshooted and removed from a system,

while a safety ground should not be. Another rack safety tip is regarding cable management. If

zip ties are used in a rack to secure cabling or small equipment to the side or shelf of a rack, the

instinct will be to cut the excess zip tie off. To prevent injury, this should be done with a flush

cutter or a knife, rather than scissors, once set. Flush cutters provide a flat, flush cut to the zip tie

whereas other instruments might not. Without a flush cut, the chance of unintentional scrapes

and cuts while working in the racks is higher. This not only applies to human appendages, but to

other cables and rack equipment as well. The images below show the poorly cut zip tie on the

left and the flush cut zip tie on the right.

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[26] Lampen, Stephen. Audio/Video Cable Installer's Pocket Guide. 342.: McGraw Hill, 2002.

[27] National Fire Protection Association. *NFPA 70 National Electrical Code (NEC)*. 140.: NFPA, 2023.
https://www.nfpa.org/codes-and-standards/all-codes-and-standards/list-of-codes-and-standards/detail?code=70.

Figure 15: Poorly Cut Zip Tie

(Dunbar, 2023)

Figure 16: Flush Cut Zip Tie

(Dunbar, 2023)

Cables should be installed without being cinched too tightly or wrapped around other cable fasteners or screws that could potentially damage the cable. This is especially applicable to any cable carrying electricity, both the high voltage AC and low voltage AV cabling. Tightly wrapped cable can also be a detriment to workflow. Dave Rice provides an example:

> You can see this in the rack on the right side of our control room. Here the cabling is tightly bundled into zip ties and strapped into place. It looks pretty and aesthetic; however when he would take this approach with our digitization racks it really frustrated our workflow. We have to routinely clean the decks with his approach, there was no slack to slide a deck out, we'd have to mark every cable, unplug them, clean the deck without being able to power it, and then reattach everything back together… He would argue that this approach to wiring is how it's done nowadays but neglect my request which was

specifically to wire not for a modern, static system but for an agile, accessible, and

maintenance-ready system that is needed in archival digitization stations.[28]

Having cables dressed too tightly can be a problem and create the need for more effort to work.

Michael Difilippo summed up Dave's point more simply, "[A] wired beauty is not always

useful."[29] A successful rack should toe the line between perfectly organized and flexibly

functional. Greg Helmstetter's methodology is similar: "I think the most important thing about

rack systems is they need to be flexible because you're going to have different people coming in

here trying to do different things with them[30]." This will come down to need and will vary from

person to person, but finding the right balance for you is essential.

<div align="center">**Documentation**</div>

Design

The importance of documentation when it comes to a system cannot be overstated. This

is as true with a video rack as it is with complex artwork, in which case, it may be more

important. Documentation can take on many forms, but ultimately, whatever is going to

accurately capture how the system was built at the time of drawing is the correct one. A basic

primer of how documentation works in new construction is as follows: a list of needs is created

along with a budget, a design is created and then proposed, a bill of materials is created, a final

pre-build design is finalized. A cable schedule (also known as a "run list") is created based on

the drawings. Following all this, a system is built and tested, labelling every cable and piece of

equipment (as called out in the drawings) along the way. Provided everything was installed

based on the drawings and the system works as intended, the drawings are then finalized. If

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[28] Dave Rice, interview by author, February 6, 2023.
[29] Michael Difilippo, interview by author, February 6, 2023.
[30] Greg Helmstetter, interview by author, April 5, 2023

anything has changed, redlines are created based on installation and a final, "as build" set of

drawings is created. These last two steps should happen based on any changes to the system.

This is, in an ideal new construction, how documentation would take place.

This is not always the case and, furthermore, not always needed for a system. A cable

schedule, or run list, is a document that lists every cable within the system as well as information

about it. The important information is cable type, cable length, termination types, where it is

going to and where it is coming from, as well as cable name/number designation. Stephen

Lampen discusses in *Audio/Video Cable Installers Pocket Guide* the act of planning an install.

His sample task plan includes, among other items: number of racks and containers, the footprint

of those racks, what equipment is in each rack, rack cables, inter-rack cabling, cable type, cable

length, total of the number of cables, and connectors needed.[31] The same could be noted for the

drawings; that all the information was captured on the cable schedule. Having both is not

necessary all the time; it depends on the size of the system and, more importantly, the end user.

Who will be responsible for this equipment once the installation is complete? An important

distinction to make is that when referring to documentation it is from an AV integration

perspective, and not necessarily the type of documentation one would find in an art conservation

context. This is merely, from a physical perspective, how the system was designed and how it

currently operates. These types of documentation are not separate from the artwork style of

reports; on the contrary, they can be quite compatible with each other. When documenting an

artwork, these technical documents could prove to be crucial in understanding an artwork. I

make the distinction only to point out that the type of documentation created for an AV system

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[31] Lampen, Stephen. Audio/Video Cable Installer's Pocket Guide. 342.: McGraw Hill, 2002.

may differ from those found currently in cultural heritage institutions as well as suggest that they

could be a great addition to other documents.

Importance

The most important aspect of this documentation is that those who will be using it can

read and comprehend the documentation once it is complete. From my interviews, I noticed the

wide variety of ways that different institutions capture their racks or art. Kelly Haydon

mentioned that she received a "dump of equipment" from a donor once and had to buy additional

parts to put it together[32]. To start this process, she figured out what the needs were and created an

outline drawing she could follow while building the rack. Conversely, Jochen Saueracker notes

that when it comes to AV art, some elements are difficult to capture:

> Good documentation should include a spreadsheet naming and counting the elements of
>
> an artwork and a poem describing the way they were used. So, it must be technical and
>
> poetic in a way… You can't have only a numeric description because a numeric
>
> description doesn't help you. Poetic things that are not describable in numbers. It's like
>
> the moment when you drop a cable, for example, I used this example describing the
>
> conversation with my old teacher when we talked about how to run the wires, he came up
>
> with a theme that we must close our eyes and then have the cable just drop at a certain
>
> moment. And at that moment, not to think about it, so this doesn't fit into a spreadsheet,
>
> but you must get a description that puts a person into the mindset that is necessary…[33]

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[32] Kelly Haydon, interview by author, January 17, 2023.
[33] Jochen Saueracker, interview by author, January 26, 2023.

Jochen is saying that you might be able to capture the elements, such as cable or equipment,

being used in an artwork, however that does not fully capture the art. Returning again to his

example of a cable dropped, once a cable or piece of gear is no longer acting as merely a

function device, but as a sculptural once, it becomes more difficult to set up should something go

wrong or if the artwork is placed in storage. His solution is a poem that attempts to both describe

the process originally used to install that piece, in addition to placing the reader in the headspace

of the moment.

Diagrams

Documentation can also have different levels of complexity to them which comes down

to the preference of the person writing it. Some people prefer a simple drawing with photos such
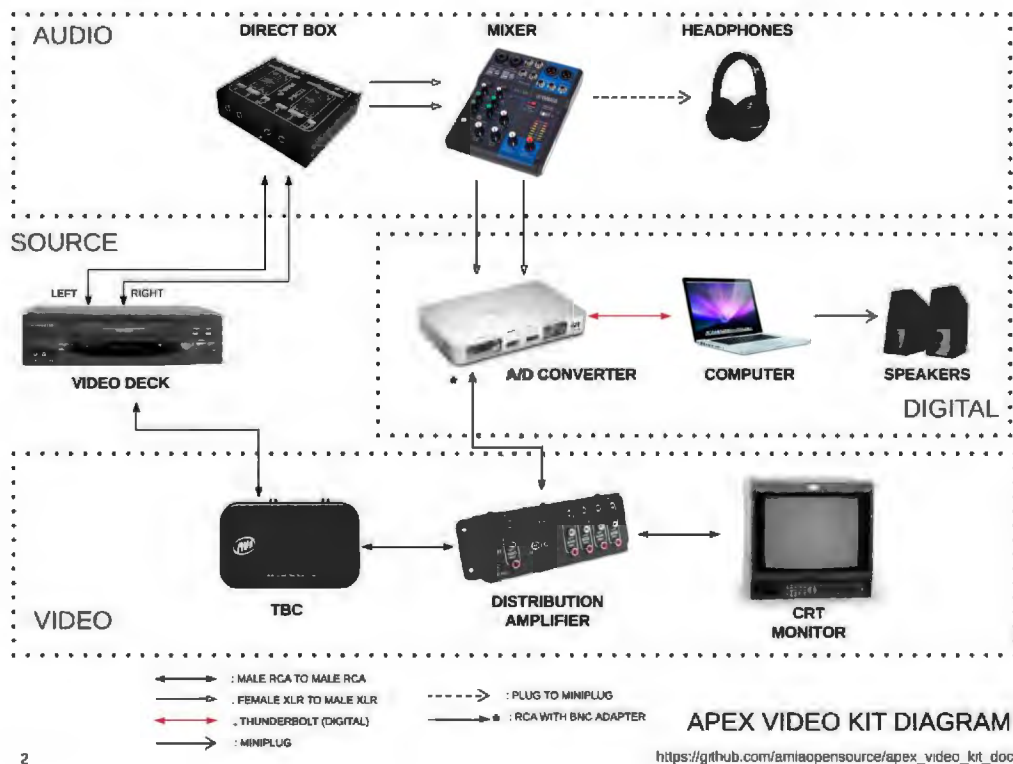
as the APEX kit's drawing:

Figure 17: APEX Kit Diagram (Amiaopensource, 2017)

The APEX kit drawing is based around photos and color coding to show the workflow of the system. There is not as much complexity here as it is meant to be a simple, easy overview of how it works. Note how the arrowed lines are different, both in color and arrowhead type, depending on the cable type. This drawing is successful in showing the basic workflow of the kit and provides a good understanding of how it works. However, if one were trying to build out this kit knowing only the most basic of AV knowledge, this might be a challenge. Furthermore, the cables are color coded, which is a great visual indicator for a drawing set, but they have no label to say what they are. Should these drawings be printed or shown in black and white, then some confusion may arise as to how to build this kit. With that in mind, it is important to note that these drawings could be perfect for somebody with a high level of knowledge or experience as well as somebody who is familiar with the kit and only needs a reminder of the workflow.

Another example of drawings is this more detailed set for the viewing room at The Museum of Modern Art (or MoMA).
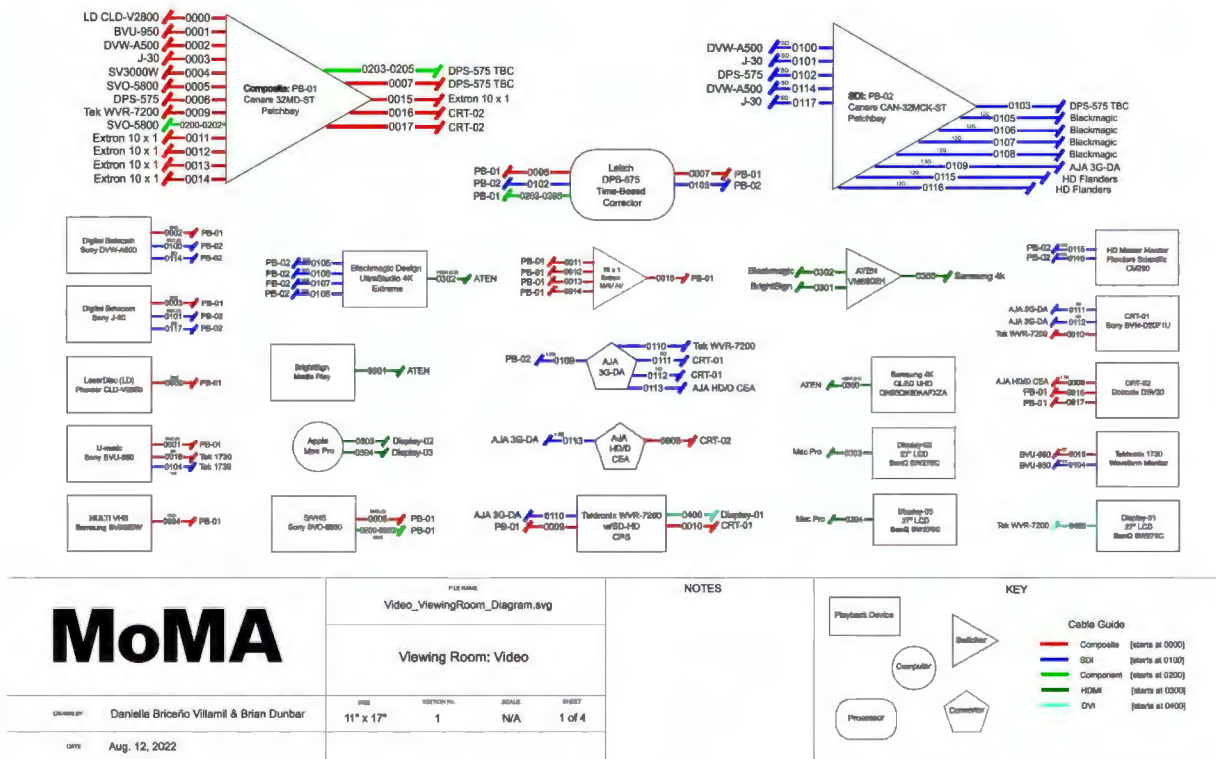
Figure 18: MoMA Viewing Room Diagram. Image Courtesy of MoMA (Villamil, 2022)

This document is set up much differently than the APEX diagram. It should be read left to right; the left side is inputs, and the right side is outputs. This is an attempt to show the flow of a cable leaving one piece of gear and entering another. These pieces of equipment are also coded to what type of gear they are: playback device, switcher, convertor, processor, or computer. While this diagram is similarly color coded, an attempt was made to number each cable and label its destination at the end of the cable. This is to make it easier to read as well as to prevent the drawings from becoming difficult to decipher if printed in black and white. A key is provided in the bottom right-hand corner to explain the drawings. The viewing room was also split between four different drawings depending on the type of workflow: video, audio, data, and power. These drawings are meant for the more technically minded and may be more difficult to read for those unfamiliar with drawings. The difference, however, is that the MoMA set provides significantly more information as opposed to the APEX set. Of course, the APEX kit is also a significantly

smaller, less complex system than MoMA's viewing room. There is another style of drawing that

you will commonly find among AV integration. The main difference between this drawing and

MoMA's is that the lines connect to the next piece of gear instead of merely mentioning the

destination. In addition, there is no color code, and the designation of device type is written out

instead of shaped. However, these are not broken out only by workflow, but by workflow and

space. For example, this is a video workflow that shows the video equipment in different racks

and rooms depending on which drawing you are on. The below refers to one room in a system,

and shows data and video as a kind of hybrid between a workflow and diagram.
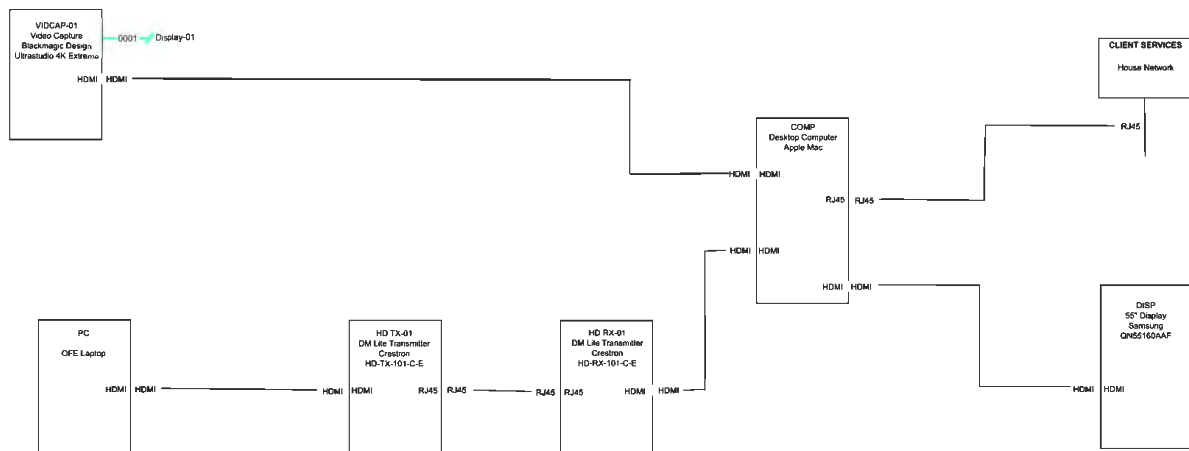
Figure 19: Integrator's Style Diagram (Dunbar, 2023)

The above example could show the video equipment in conference 101, while a similar drawing

would show the video equipment in conference 102. This is instead of showing all video on one

page leading to a larger drawing set.

Reference Documents and Equipment Lists

Something Daniella Villamil and I experimented with when working on MoMA's

drawings was to create a few pages at the beginning of the set to make everything a little easier

to read[34]. We added an equipment list as well as a section of some images related to what some

pieces of gear looked like (partially depicted below).

MAKE	MODEL	DESCRIPTION	LOCATION	VIDEO/AUDIO
SWITCHER				
ATEN	VM0202H	HDMI Matrix Switcher	Desktop	Video
AVP	AP-B248E2-L-HN-RPT	Audio Patchbay (PB-03)	RACK-02	Audio
Canare	32MD-ST	Video: Composite Patchbay (PB-01)	RACK-02	Video
Canare	CAN-32MCK-ST	Video: SDI Patchbay (PB-02)	RACK-02	Video
Extron	MAV AV	10 x 1	RACK-02	Audio
PROCESSOR				
Grace Design	m908	Reference Monitor Controller	RACK-02	Audio
Leitch	DPS-575	Time-Based Corrector	RACK-02	Audio
Tektronix	WVR-7200 w/SD-HD CPS	Waveform Rasterizer	RACK-02	Video
CONVERTOR				
AJA	3G-DA	Distribution Amplifier	RACK-02	Video
AJA	HD/D CEA	HD-SDI to Analog Audio/ Video	RACK-02	Audio, Video
Rolls	MB15B Promatch	Unbalanced to Balanced Audio Converter	RACK-01 & 03	Audio
Tripplite	Isobar	Power (PWR-01, 02, 03)	RACK-01,02,03	
PLAYBACK DEVICE				
Apple	Mac Pro	Computer	Left of Desktop	Audio, Video
BenQ	SW270C	27" LCD (Display-01)	Desktop Monitor	Video
BenQ	SW270C	27" LCD (Display-02)	Desktop Monitor	Video
BenQ	SW270C	27" LCD (Display-03)	Desktop Monitor	Video
Blackmagic Design	Ultrastudio 4K Extreme	Capture and Playback Device	RACK-02	Video
BrightSign	TBD	Media Player	TBD	Audio, Video
Dotronix	DSV20	CRT Monitor (CRT-02)	RACK-03	Video
Flanders Scientific	CM250	HD Master Monitor (Display-04)	Desktop Monitor-04	Video
Genelec	8020D	Speaker	Rear Wall	Audio

LAB: Viewing Room   Last updated: July 2022   1

Figure 20: Example of Equipment List. Image Courtesy of MoMA *(Villamil, 2022)*

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[34] Daniella Villamil and I were both graduate interns at the Museum of Modern art in the summer of 2022. She is from the University of Delaware graduate program in Art Conservation

The equipment list in the front of the set is an attempt to better explain the drawings for those inexperienced or have difficulty following the drawings. The equipment is split up by the type of gear and then alphabetized. Each line provides the make and model of the device as well as a brief description of what it is, the location, and to which section of the drawings each piece corresponds. Each item in the list corresponds to a device within the later drawings and the ttempt is made to connect those.

The photos of the space (Rack-03 shown here) show how items are currently set up in the space as well as a type of rack elevation. Rack elevations are common in drawing sets and usually act as one of the first pages of a section. Elevations tell you what equipment is in each rack, where it goes, and approximately how much space it will take up. It may also tell you if it is connected to other racks, depending on if it is a multi-rack setup. At the time of the creation of these photos and diagrams for MoMA, the room was still being set up.
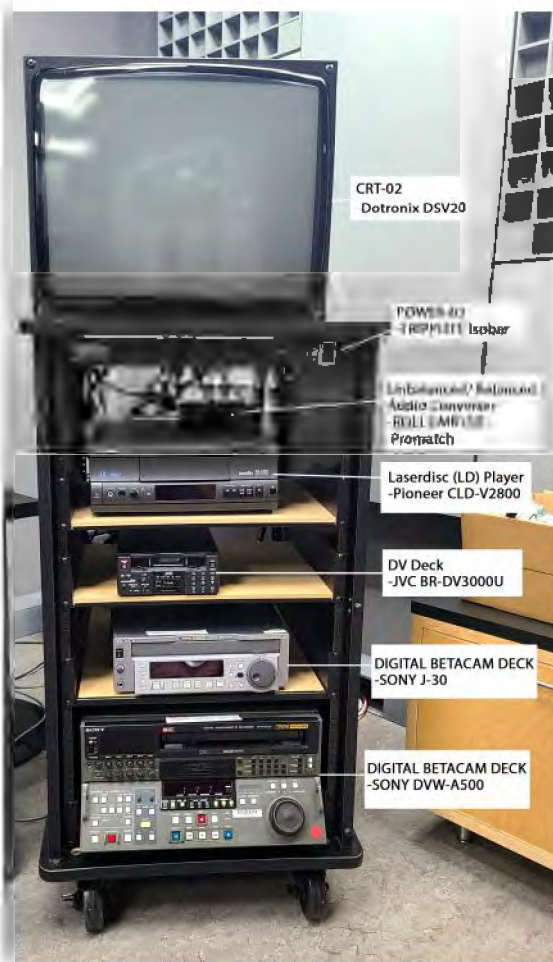
Figure 21: Photo Style Rack Elevation,
Image Courtesy of MoMA *(Villamil, 2022)*

Labeling

Figure 22: Labeler (Dunbar, 2023)

Potential next steps might be to label each piece of gear, or the shelf below or above it. The label can list the device ID or device name from the drawings, the full make and model, or even a brief example of what it is. For example, the Digital Betacam Deck in the photo, the Sony J-30, could be listed as Digibeta Deck, Digibeta, Sony, J-30…. Whatever makes most sense for the institution using it. Another important label, according to AVIXA's rack building standards, is to provide the serial number as a separate label on the back of the piece of gear.[35] This is recommended as manufacturers sometimes place the serial information on the bottom of the equipment, which may be inaccessible once installed in the rack. Some recommendations for labels would be to use a label maker similar to one found in a home environement, or a more professional style p-touch machine. Both will have the option of different sizes of tape and different colors which will allow for more organization or aesthetic choice. Another option, depending on the rack, is to get plates made that could screw into a shelf. Plates are more permanent but may cost more and become invalid if equipment changes or is replaced. A cheaper option would be tape and marker: gaffers' tape, electrical tape, or whatever sticks. Another alternative is to make a sign with paper and hang it using tape, magnets, hooks, or some kind of fastener such as a zip tie or string. This is cheap and easily replaceable and could be useful for lower budget projects. Neither of these may not look as clean as a label or a plate, but the importance of aesthetics is up to the institution. One note on labels is that if the room gets hot or humid, or there is heat blowing onto the label, the adhesive may wear quicker and could

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[35] Audiovisual and Integrated Experience Association. AVIXA F502.01:2018 Rack Building for Audiovisual Systems. N.P: AVIXA, 2018.

potentially fall off. On the subject of labels, it is perhaps most important to label the cabling itself.

When troubleshooting a cable, it may sometimes be difficult to tell which cable goes where. The label may list the cable number on it, or it may be more detailed such as listing where the cable lands on both ends. In either case, the label would ideally correspond to a cable schedule, a run list, or a drawing. These labels allow for easier troubleshooting as it helps to prevent errors due to cables being mis-wired. Much like rack labels, there are various options for cable labels. There are companies, such as Brady, that make handheld label makers for cables (pictured here is their M210) that are moderately affordable if a nicely wrapped cable is the desired outcome. There are also wired or Bluetooth printers available that can print rolls of cable labels from a spreadsheet or database if the project is larger in scale. A p-touch label could also be used and turned into a kind of flag with the information on it to allow for something that pops. You may also find colorful cable labels sold that work in a

Figure 23: Brady Wire Labeler (Brady, 2023)

similar fashion. When the money in the budget is tight, using some electrical tape and a permanent marker may do the trick as well. Alternatively, if the cable is light enough in color it can be written on without the use of tape. The standard for cable labels is to place it around six inches from the end of the cable. In practice, try placing the cable in your fist with the

termination outside of your hand on the one side. The label should go on the section of cable on the outside of the other side of your hand. This practice makes the label easier to read as well as protects yourself from having to reprint the label when troubleshooting later, should the cable need to be re-terminated. A brief trick of the trade: if the cable label needs to be removed or replaced, you can take a seam ripper normally used for sewing and use that to remove labels already wrapped around the cable.

It is important to note that the labeling of equipment and cables applies more to a digitization station than it does to AV artworks. An artwork may utilize equipment as both a functional and structural piece – i.e., the cables and equipment are visible. Adding any labels may be undesirable for aesthetic reasons. Having labels on view that were not part of the original artwork could be a detriment to the work. From a preservation standpoint, adhesive could cause unnecessary deterioration to aging equipment and leave markings when removed. Labels may also imply messages to the viewing audience that were not intended as part of the artwork. When installing AV artwork, it is important to be organized and careful because without labeling, it may be more difficult to troubleshoot. However, the rest of this section relating to documentation is perhaps more important to AV artworks. Without indicators of where items go, or what they are, information can more easily be lost. Having well thought out documentation that defines both the artwork as well as how it should look and be set up is crucial to its continued preservation.

Redlines

Should equipment change, cables change location, or any other changes be made, they should be documented. The process of updating documentation, whether drawings or otherwise, is often referred to as "redlining." The story of why redlines have their name comes from

engineers using a red pencil or pen to mark updates on a set of drawings. The red color helps the

changes pop, and they are less easily missed. Any color pen or pencil (or digital marking) can be

used; however, it is important that they are visible.
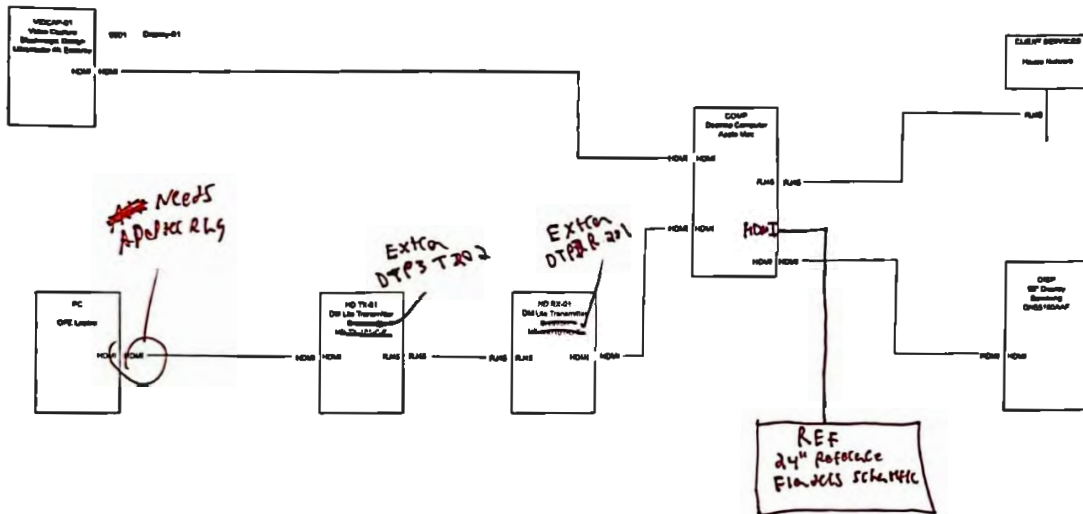
Figure 24: Example of Redlines (Dunbar, 2023)

Once these changes are marked, updates are made to the digital file and a new set is born. This

new set may sometimes be referred to as an "as build" set which means it is accurately reflective

of how the system is built in its current state. This process comes from construction and makes

sense when following a large project through numerous changes. As far as archives and

museums are concerned, what is important is to update documentation when changes are made.

If a cable is moved, have the drawings reflect that. If one model of VHS deck has been swapped

for another, even if the cabling has not changed, reflect it in the documentation. This may not

seem important, but it will prevent headaches in the long run. All these steps are meant to allow

the AV system to function properly and prevent any confusion when troubleshooting issues.

Finally, if possible, it is important to save any documentation created for the system. This documentation could be items created to explain the workflow, instructions on how to use the system, or equipment manuals, to name a few. Regarding obsolete equipment, finding service manuals will become more difficult in the future. Whether it is physical or digital, it is important to save copies of these manuals together to aid in troubleshooting over time.

Conclusion

In conclusion, archives and museums could use the information provided through the AV integration and construction industry to their benefit. AV integration is not the defining authority on all things audiovisual, but a different industry entirely. Bringing an outside perspective to the worlds of preservation and art could provide a new sense of direction, new standards and best practices, and perhaps some better methods of working with collections. Integration is not concerned with preservation in the same way that an archive, museum, gallery or library would be, but instead with a well-functioning system and how individuals and teams can work with it – whether that is to use the equipment or to repair it. While the collections that cultural heritage institutions work with are not always as clear cut and systematic as an AV system, utilizing the skills from the integration field could aid in preserving those collections by offering a new way to plan out, organize, and clean up the technology used to work with them.

Next Steps

The looming question this paper suggests is how these institutions should begin to learn the skills from integration. Originally, I set out to build a guide, realizing too quickly that attempting to fit an industry's worth of knowledge within a paper would be impossible. Instead, I provided some basic ideas about the field and created a jumping off point. In Appendix A, I provide a suggested resource list for further review, in addition to laying out what a beginner's

course might look like. The resources list includes some of the documents I used within my own research as well as courses and tutorials from integrators, manufacturers, and organizations. This can be treated as a sort of annotated bibliographic resource to find the first steps to new information. Some people learn better from videos, some from written documentation, however the crucial element to these skills is hands-on experience. Some things, like labeling a cable, are harmless if done incorrectly. Others, however, like terminating some cables, can lead to damage or harm (in worst case scenarios) if done incorrectly. The suggested course focuses more on the hands-on skills while the reading list provides knowledge of why to do these skills a certain way.

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Appendix A: Proposed Course Outline

1) **What is AV?**
    a) Introduction to AV basic concepts
    b) Introduction to Standards
    c) Introduction to tools
    d) AV Mindset: planning and building a system
    e) AV Mindset: troubleshooting a system
    f) Different cable types: jackets, fire ratings, connections
    g) Cable connectors and terminations

2) **Rack Building:**
    a) What is a rack?
    b) Rack components
    c) Rack Accessories
    d) Screw sizes and RU's
    e) Use Cases
    f) Examples of bad racks: Q&A, identification and solutions
    g) Examples of good racks

3) **Cable Terminations:**
    a) Cable stripping basics
    b) Scissors vs cutters vs dedicated cable stripper
    c) Importance of flush cuts
        i) Audio:
        ii) Introductions: XLR, Phoenix block, 1/8", TRS, Spade connectors and Speakon connectors
        iii) Diagrams/ videos for how to do above
    d) Soldering basics
    e) Walkthrough of terminations
    f) practice
        i) Video:
        ii) RCA, BNC, HDMI, s-video/dub
        iii) Diagrams/ videos for how to do above
    g) Walkthrough of terminations
    h) Practice

4) **Documentation:**
    a) Types of documentation
    b) Importance of documentation
    c) Device IDs
    d) Serial Numbers
    e) Building a runlist/ cable schedule
    f) Rack elevations
    g) Wire diagramming
    h) Introduction to diagramming tools
        i) Cable labels
        ii) Types
        iii) Machines
        iv) Device labels

Suggested Course Resources

AVIXA CTS Book :

This book is meant as a guide to prepare AV practitioners to take the CTS test. While meant as a form of test preparation it serves as a fantastic resource on the basics, and slightly advanced topics, in AV

Avixa.org

This website provides resources on the basics of AV and offers standards and trainings for various price ranges.

Equipment manuals

Searching out equipment manuals for the gear used in your system can prove an invaluable resource, especially in the case of obsolete equipment.

Manuals can be found digitized online or as a physical book depending on the equipment.

Save as many manuals as you can and share often so the knowledge does not disappear.

Lampen pocket reference

Stephen Lampen's pocket reference book is a handy guide on all things AV and can be quickly used to solve the more basic problems.

Legrand AV courses:

Legrand is one of the largest AV manufacturers in the country. They provide online trainings that cover a variety of skill levels in topics ranging from AV Racks to hanging projectors.

Matters in media art

A web based project meant to provide "guidelines for the care of media artworks". This site has resources that may apply to your AV system, but is more suited for those in a museum setting.

Reddit r/homelab

Reddit is a social media site. Nicknamed "the front door to the internet" it is setup as a variety of different communities, each with their own interests. Reddit can provide some unique ideas and hacks to make a cheaper AV system for your institution. Be careful when using this site though as not all information will be correct, use with a healthy side of caution.

Standards of AV book

A book created by Infocomm and available online that attempts to outline the basics of what AV is and how to go about doing it.

Youtube videos

There are an endless stream of youtube videos teaching you how to do AV. More importantly however there are integration companies, AV manufacturers and even standards organizations like AVIXA that have youtube channels that teach the basics.

Appendix B: Research Materials

Research Interview Prompts

1.   Have you or your institution built an AV rack yourselves or was an outside contractor

hired

2.   What is the main purpose have AV rack(s) served to you/your institution

3.   What preparation went into building the AV racks

4.   Have there been many changes to these racks since they were originally built

5.   How did you/your institution go about making these changes

6.   Is there any documentation regarding the wiring and connections within the rack

7.   Did you know anything about AV rack builds before you/your institution built one

8.   How has the wide adoption of digital equipment impacted you/your institution

9.   What is your opinion of how AV integration within cultural heritage institutions has

changed between the analog and digital eras

10.   Do you find audio or video equipment gives you the most problems

11.   How do you/your institution go about determining the best equipment

12.   How did you/ your institution decide on best practices for installation of AV related

materials and equipment

13.   Do you turn to any specific resources such as manuals or organizations when preparing for

an AV artwork installation or digitization?

14. What do you like about your rack setup? (Or some that you have worked with)

15. What do you dislike about your rack setup? (Or some that you have worked with)

16. Do you fabricate your own cabling, or do you purchase pre-made cables? Any specific

preference as to make/ model?

Adapted Research Interview Prompts for Museum Context

1. Where or how did you get your education about audiovisual equipment?

2. How has the change between the analog and digital eras affected your work?

3. What are the main changes you've seen in how AV artworks are set up over time?

4. What is the relationship between AV equipment and the artwork?

5. When does the equipment or cabling become part of the artwork? Is the installation itself an art?

6. What is the most difficult part of setting up an AV artwork that has been in storage?

7. What kinds of video tape decks and other audiovisual equipment do you use in the lab?

8. Do you have equipment set up to perform transfers from analog media like videotape to digital media?

9. Do you experience more trouble/ need for troubleshooting with audio or video equipment?

10. What do you feel is the importance of documentation when building an AV artwork?

Interview Request Form

Dear _____,

My name is Brian Dunbar and I am a second year graduate student at New York University, in the Moving Image Archiving and Preservation (MIAP) masters program. Under the supervision of Amy Brost, Associate Media Conservator at MoMA, I am writing my thesis on Audiovisual equipment rack and artwork building processes. In order to better understand institutional needs for AV setup, I think it is valuable to interview practitioners who have understanding of rack building or rack use in an institution and/or the transition from analog do digital equipment in an archival setting.

Would you be willing to be interviewed about your professional role in developing audiovisual archival workflows and your experiences with selecting and setting up audiovisual equipment? The audio from the interview will be recorded and may be transcribed. I would also be happy to share the recording and/or transcript with you.

I would love to get on your calendar, ideally by the end of December, but also understand that the holiday season is here and January may better accommodate your schedule. Thank you for considering my request and I look forward to hearing from you. Have a wonderful day.

Sincerely,

Brian Dunbar-CTS

Consent Form

NYU

Moving Image and Archive Preservation Program
665 Broadway, Room 637
New York, NY 10012

P: 212 998-1618

Consent Form for IRB-FY2023-7068

You have been invited to take part in a research study to learn more about how AV systems can be set up to work effectively and to avoid danger to users, systems and artworks. This study will be conducted by Brian Dunbar, TISCH - Cinema Studies, Tisch School of the Arts, New York University, as a part of his Master's Thesis. His faculty sponsor is Adjunct Instructor Amy Brost, Department of TISCH - Cinema Studies, Tisch School of the Arts, New York University.

If you agree to be in this study, you will be asked to do the following:
- answer questions in a one-on-one interview

You will be audio, video, and photo recorded. You may review these recordings and request that all or any portion of the recordings be destroyed. Participation in this study will involve 1-2 hours. There are no known risks associated with your participation in this research beyond those of everyday life.

Although you will receive no direct benefits, this research may help the investigator understand how AV systems can be set up to work effectively and to avoid danger to users, systems and artworks. Unless you agree otherwise (see below), confidentiality of your research records will be strictly maintained by keeping all interview recordings, transcripts and email correspondence in NYU systems and on the researcher's secure personal devices only. Your information from this study will not be used for future research. Participation in this study is voluntary. You may refuse to participate or withdraw at any time without penalty. For interviews, questionnaires, or surveys, you have the right to skip or not answer any questions you prefer not to answer.

If there is anything about the study or your participation that is unclear or that you do not understand, if you have questions or wish to report a research-related problem, you may contact Brian Dunbar at 212-998-1600, bd2150@nyu.edu, 721 Broadway, 6th Floor, New York, NY 10003, or the faculty sponsor, Amy Brost at 212-708-9400, alb240@nyu.edu, MoMA, 11 W 53rd St, New York, NY 10019.
For questions about your rights as a research participant, you may contact the University Committee on Activities Involving Human Subjects (UCAIHS), New York University, 665 Broadway, Suite 804, New York, New York, 10012, at ask.humansubjects@nyu.edu or (212) 998-4808. Please reference the study # (IRB-FY2023-7068) when contacting the IRB (UCAIHS).

___ Yes, I give the investigator permission to use my name when quoting material from our interview in his/her dissertation, presentation, or publications.
___ No, I would prefer that my name not be used.
You have received a copy of this consent document to keep.

Agreement to Participate

_____
Subject's Signature & Date

Appendix C: Selected Transcripts

<u>Kelly Haydon</u>

Brian Dunbar: Okay. So that could lead to a bunch of different questions.

So just take a step back and reiterate, a lot of this gear

came in large dumps of equipment that you received from

artists or donations from somewhere. You looked through

what you had to see, what can we make out of this? Then

what you didn't have, but needed, you filled in the blanks

by either finding it on Craigslist or eBay or seeing who

else in the collective or friends of yours had it and then

building from there?

Kelly Haydon: Yeah, pretty much. I mean, what we have, what nonprofit

organizations, or at least we're barely even that, we're a

collective. We have more agility than institutions, so we

can just do that. We're not hampered by a lot of the

bureaucratic red tape that comes with trying to buy this

equipment, like in some other institutions.

Brian Dunbar: If you ever make changes to the rack, does that happen

often? Where you actually have to swap equipment out?

Kelly Haydon: Um, yeah, we try not to do that. We do try to, at least the

racks that we have up now, most of the racks that we have

set up do have a patch bay or a switcher situation where

we can switch, you know, we can use a routing system so

that we can switch between the decks. They are at that

level of sophistication at least. It's a little harder for us to

set up audio because there's kind of a lack of skill, but we

do have it set up now so that you can switch between U-

Matic and VHS with the Patch Bay.

Jochen Saueracker

Brian Dunbar: I was going to ask, what are the main changes you've seen

and how AV art works are set up over time? But I'm also

curious to add to that is how they're received, specifically

ones you might've worked on?

Jochen Saueracker: Let's see. Let me go back to your question first, because I

took the first note of this...The main change I've seen…

that most of the artists have passed away now. That was

my first response to the question. What has not changed is

the lack of understanding of the relation of technical items

and the artwork. That hasn't changed. That is still

confusingly present, I talked to, like a week or two weeks

ago, I was in a gallery and we talked about artworks from

the late eighties and the approach the guy had in the

gallery was pretty much the same as the person would've

had 30 years ago. It was really interesting to understand

that, or to see there is no development in this, like imagine

you have this very old Nam June Paik artwork, a platform,

a human size, whatever, you try to define what is the

beginning and the ending of the artwork. So, does it start

with a plug that comes out from the artwork? Does it start

with a power cord that goes into the artwork? For a lot of

people this is very unclear and not defined. And being in

an identical situation like this after 30 years again, I

thought that's very interesting that still there isn't a

definition, a clear point that describes the artwork

beginning at the end of this cable.

Dave Rice

Dave Rice: One engineer had a very different approach to wiring. You

can see this in the rack on the right side of our control

room. Here the cabling is tightly bundled into zip ties and

strapped into place. It looks pretty and aesthetic; however,

when he would take this approach with our digitization

racks it really frustrated our workflow. We have to

routinely clean the decks with his approach, there was no

slack to slide a deck out, we'd have to mark every cable,

unplug them, clean the deck without being able to power

it, and then reattach everything back together. It made

cabling take far longer and gave us an ongoing risk of

miswiring by forcing us to disconnect and reconnect every

cable when we had to clean the deck, which could be

several times a day. I had several arguments with him, as I

needed the decks to function, and he prioritized this

instagrammable, neat, tight, and immoveable system of

wiring. He would argue that this approach to wiring is how

it's done nowadays but neglect my request which was

specifically to wire not for a modern, static system but for

an agile, accessible, and maintenance-ready system that is

needed in archival digitization stations.

Dave Rice: Another challenge about working with this engineer was

accommodating an insistence that every deck had to have a

fixed, wired input and output, even though it wasn't

necessary at all. I wasn't planning on recording new U-

matic tapes or Betacam tapes but he would insist that this

is how it's supposed to be done. So all the disconnection

and connection required for cleaning a deck were doubled

and we had the rack clogged up with a lot of cables that

didn't need to be there. Later we did find that we could

recycle those extra cables to purposes we needed (like

when we'd add in a new videodeck).

<u>Greg Helmstetter</u>

Greg Helmstetter: You can still theoretically switch out the decks more

easily. So that's really the purpose of it all is to show

these different functionalities. You really could simplify it

and just send the video out through the TBC and then to

the digital capture card and that would be it. You don't

need all those other bells and whistles. But it's used as

this educational tool to show students that this is why, this

is how you calibrate things. These are all of the

maintenance aspects of the AV system, and you should be

familiar with their role if not well versed in them,

depending on what you want to do down the road. A lot

of the people we're training are going to be people who

have to do these things on their own. They're not going to

be able to afford vendors who can do these things. So, it's

partly teaching troubleshooting. I think that money and

budget play a huge role in what people can do on their

AV rack systems. I mean, I've never worked for a system

or for a company that's been like, yeah, we can afford to

do whatever we want. There's always some sort of

budgetary restriction. I'm sure they exist, but I've not worked for them.

Brian Dunbar: I'll tell you that's not always the best thing either.

Greg Helmstetter: It definitely is not. Cause then you've got a bunch of extra crap that you don't need that becomes critical and it can fail and then you don't know how to get around that.

Glossary:

Term	Definition
As Build	The final version of a drawing set, created from the original set and red line markings.
AV	An abbreviation of Audiovisual
AV rack	Enclosure designed to hold various components, usually electronics.
Avixa	Audio Visual and Integrated Experience Association. A non-profit standards organization for audiovisual and related industries.
Cable Management	Management of cables, also known as wires, in an AV system to prevent them from becoming tangled or caught.
Cable schedule	A document that contains a list of the cables in an AV system designating type and destinations. Also known as a run list.
Cable tie	Fastener designed to hold cables together.
Category cable	An ethernet or data cable.
Flush cuts	Scissor-like tool designed to cut wires on a flush, or straight, angle.
Grounding	The connection of a system or piece of equipment to the earth's ground. Grounding creates an alternate pathway in which electrical currents can flow should issue arise in the electricity of a system.
IEEE	Institute of Electrical and Electronics Engineers. A professional association dedicated to electronics engineering.
Impact Gun	A power tool which delivers a high torque output. Also known as an impact wrench.
Label	Item used to identify something; in the case of this thesis, generally a piece of AV gear or cable.
OSHA	Occupational Safety and Health Administration. A regulatory agency of the U.S. Department of Labor whose purpose is to assure safe and healthy working conditions.
Patch Cables	Cables in a system not permanently affixed to equipment. May be inserted into a Patch Bay to facilitate temporary signal flow
Phoenix block	A low voltage connector and terminal block often used for audio or control signals. Also known as a Euroblock.

Plenum airspace	A compartment or chamber in which one or more air ducts are connected and that forms part of the air distribution system.[36]
Plenum cable	Cabling designed for plenum airspaces.
Rack rails	Pieces of metal that run the vertical length of an AV rack which contain evenly spaced screw holes. Rack rails are meant to hold rack screws and support AV rack components and equipment.
Rack unit	Standard vertical spacing in an AV rack. 1.75 inches high.[37]
Red line	Markings on a drawing indicating a change. Named because of the red pencil or pen originally used by drafters.
Run list	See cable schedule.
Screw Gun	A power tool meant to drive screws into a given object.
Shielding	A foil-like layer found inside shielded cabling meant to protect the interior conductive layers from electromagnetic interference.
SMPTE	Society of Motion Picture and Television Engineers. A professional organization of media professionals, technologists, and engineers working in the media and entertainment industry. [38]
Standard	A rule or methodology of how to do something established by an authority.
Terminations	The end of a cable where a connector is attached to complete the transmission of data.
Tweaker	Informal term for a screwdriver designed for tiny screws. Sometimes referred to by AV technicians as a Greeny/Greenie.
Wire diagram	A schematic representing the wires and components for an AV system.
Wire Strippers	A tool designed to remove or "strip" the outermost layer of a cable.

[36] NEC article 100, page 56.
[37] Ciddor, Andy. CTS Certified Technology Specialist Exam Guide. 3rd ed. 149.: McGraw Hill, 2019.
[38] "Who We Are." SMPTE. Accessed April 28, 2023. https://www.smpte.org/who-we-are.