

# A UNIVERSAL FORMAT FOR ARCHIVAL TAPE

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This year is the 40th anniversary of the Ampex Quadraplex Videotape Recorder introduced in 1956. The quad format dominated for over 20 years, until it was finally replaced by the one inch type C format in 1978. Now, thousands of Quad tapes are sitting on archive shelves and many of them will probably die on the shelves.

## I. Introduction

For most people in the TV Industry, the new videotape formats introduced at the National Association of Broadcasters Symposium in Las Vegas each year are exciting technological advances. But, for a person responsible for preserving the information recorded on videotapes, growth in the number of formats is a constant headache.

Archives have collected vast numbers of videotapes in many different formats. While archivists wish to preserve this information, most institutions only have the resources to operate a few pieces of videotape equipment. Commonly, VHS and 3/4" U-Matic machines are found in smaller institutions, Betacam in a few others. Most do not have access to older broadcast equipment like Quad or 1", and almost none have any of the newer digital equipment. The majority of these institutions are forced to reject acquisitions in formats they can not handle. If they do choose to keep these tapes, it is often without any realistic hope they will ever be able to see the images or preserve them.

A national awareness of this problem is needed in the video industry.

## II. Obsolete formats

Figure 1 gives an idea of how many videotape formats exist in archives today. Any one archive may have as many as 20 different tape formats. How can they find the equipment to play tapes made on all of these formats? That is the question many archivists face almost daily.

While most archives are unable to manage all of these different formats, the larger video archives have been forced to become de facto operating videotape equipment museums in order to collect and preserve all the documents that exist on these various formats. Archives without the proper playback equipment must rely on a special transferring laboratory that has the equipment, as well as, a good reputation for handling obsolete tape formats.

While archivists are trying to cope with the overwhelming tide of tape formats, new formats continue to be introduced. At NAB-96, the DV formats were being pushed by Sony and Panasonic, and JVC was pushing Digital-S. There is no sign that this explosion in the number of formats will die down in the near future.

### **III. Tape Formats Suitable for Archiving**

I recommend digital over analog for archives because digital provides the ability to monitor error rate and to make copies with no loss in image quality.

D1, D2, D5 and DCT are good archival formats, but they are too expensive for budget-conscious archivists.

I advise against formats that use ultra-thin tape. The 10 um tapes are exceptionally susceptible to damage, and recovery of the data is very difficult after damage occurs.

I recommend against using a format with compression. For an archivist, compression is a potential disaster. After years of storage, some of the key bits could be unrecoverable and cause an entire table of bits to be lost or jumbled. Another problem with compression for archival tapes is that archival material should never be altered, and compression is certainly a form of alteration.

### **IV. The Main Tape Archival Problems**

Most of the archives I have visited have inadequate budgets and cannot properly care for the material they have.

Aside from the budget problem, the two main problems faced by archivists are:

#### **A. Obsolescence of Formats**

An example of an obsolete format is quad. Many archives have quad tapes but no quad machines. Maintaining a quad machine is very difficult because of the many electrical and mechanical adjustments needed and because of lack of replacement parts.

Recently, CBS-Hollywood completed the transfer of 32,000 quad tapes to a new format. Out of 32,000 tapes, only two were unplayable. That says something about the durability of the quad format. This is an admirable example of management deciding that the old material was valuable and finding the money and the resources to save it. Unfortunately, this is not really the norm. All too frequently, old format tapes are discarded when they become difficult to play and there is no money available to remaster them to a more modern format.

#### **B. Deterioration of Tapes**

Most tapes manufactured between about 1970 and 1990 were made with a binder that is not stable. This binder problem wasn't known until Ed Cuddihy, at the Jet Propulsion

Laboratory, discovered that these binders break down at high temperature and/or high humidity. Since Ed Cuddihy published his paper in the *IEEE Journal* in 1982, most tape manufacturers have developed a more stable binder for their product.

Because of potential liability problems, tape manufacturers are reluctant to discuss the binder issue. There is a need for an ongoing study of the binder durability of the various tapes on the market, and this should be done by an independent laboratory. The implication of not doing so is that information can still be recorded on tapes with a poor binder and will suffer binder deterioration in the future.

## V. The situation through the eyes of an Archivist

### A. The main functions of a videotape Archivist are:

1. **Collecting:** This includes selecting items or collections in accordance with policies and needs of the larger institution of which the particular archive is a part.
2. **Organizing:** Arranging the collections in a usable order.
3. **Conserving:** Storing the collections in a proper environment
4. **Cataloging:** Providing intellectual access to the items in the collection.
5. **Accessing:** Providing playback equipment for the items in the collection.
6. **Preserving & Copying:** Making faithful copies of the old material onto a modern format.

### B. Too many tape formats:

Because of their limited budgets, archivists usually choose one or two formats to support, leaving the others in the dust of technological change. The existence of many formats wastes the archivist's time in determining the best format and players to acquire. When archivists find the money to transfer endangered materials to a new format, they can only hope that they have chosen a format that the tape and machine manufacturers will continue to support, and that the new tape will remain a stable medium for long-term storage and retrieval.

Video archivists are very concerned with "orphan" formats--formats that are no longer supported by the equipment manufacturers. The requirements for specialized maintenance and repair is increasingly difficult for archives with old equipment.

### C. Lack of playback equipment:

Some archival material is not known because the archivist cannot play the tapes to verify the contents. They are lacking either the proper machine, an experienced expert to operate and maintain it, or replacement parts. The longer this problem is

allowed to persist, the more likely the tapes are to become worthless. If the tape contents cannot be identified with reasonable certainty, the space they occupy will be seen by administrators as more valuable than the materials currently housed there. This is especially true for tapes which take up a lot of shelf space, like 2" quad and 1" Type C. And, indeed, even the archivist is hard pressed to make a convincing argument for continuing to collect and house videotapes whose actual content is unknown. If the Archivist allows the videos to die, our society loses some of its popular culture and some of its history. The videotapes then become technological museum artifacts with essentially no informational or cultural value.

#### **D. Triage:**

Archivists are conditioned to protect and cherish each item in their collections. It's difficult for an Archivist to think in terms of choosing which items are to be handed down to future generations and which items will probably die on the shelf. In effect, archivists must function as battlefield and/or emergency room doctors, making triage decisions, usually with inadequate information on the patient.

Therefore, it behooves an Archivist to attempt to preserve the life of as many of their patients as possible through conservation efforts. This is done by trying to preserve items in their current physical form, moving videotapes into archival quality containers, and controlling temperature and humidity. Additionally, this is accomplished by copying deteriorating material and videotape formats which are endangered by impending obsolescence. As formats continue to die, archivists are forced to play a kind of copying roulette to try to keep the information alive and accessible.

There is hope.

### **VI. Report by Library of Congress**

In March 1996, the Librarian of Congress, James H. Billington, held three public hearings for the purpose of receiving input about American Television and Video preservation efforts.

As a result of these hearings, the Library of Congress formed three task forces to make recommendations about preservation of the U.S. Television and Video heritage. These task forces have completed their reports and the full report will be published early in 1997. This report will be very important in clarifying and resolving the issues faced by videotape archivists worldwide.

### **VII. Call for a Universal Tape Format**

Tape recorders are now available that can record either video or data. Since all digital tape recorders operate in the digital domain, it makes no difference whether the input signal is digital, analog, audio, video, or data. This opens up the possibility of a truly

universal tape recorder. The best solution for the archivists' nightmare of dozens of formats, is to develop one such universal format for all archival needs. To do this, SMPTE (Society for Motion Picture and Television Engineers) should join with AMIA (Association of Moving Image Archivists) and develop guidelines/specifications for a universal format.

This has a precedent, in that, 20 years ago, a similar request was made by the U.S. TV networks to prevent Sony and Ampex from marketing two incompatible formats. As a result of this request, a special committee was formed, and the first SMPTE videotape format (Type C) was adopted in 1977. Both Sony and Ampex received an EMMY for agreeing to the compromise (C) format rather than engaging in a format war.

### VIII. Conclusion

The present system of storing our Television and Video heritage on multiple videotape formats for later retrieval is **not** working. The Librarian of Congress, in conjunction with the National Film Preservation Board, has issued a call to action by assessing the state of television and video preservation in the United States and by submitting its report to Congress in 1977.

It is time that the Technical Community work with the Archival Community to develop a universal tape format.

#### Notes:

1. Another version of this paper was presented by Jim Wheeler at the SMPTE Conference in October. The title was "Surviving in the Format Jungle."
2. Thanks to Charles Lamb, Archivist at the University of Notre Dame; Linda Elkins, Archivist at the University of Georgia; and William O'Farrell, Archivist at the National Archives of Canada for their help with this paper.

# VIDEOTAPE FORMATS

	Professional	Industrial/Educational	Consumer
1956	Ampex 2" Quad		
1960	Ampex Quad Low-Band Color		
1962		Ampex 2" Helical (First popular helical)	
1963	Ampex Quad High-Band Color	Sony 2"	
1964		Sony 1"	
1965		Ampex 1" (SMPTE A)	
1968		IVC 1"	
"		Sony 1/2"	
1969		ELAJ-1 1/2"	
1970		Phillips 1/2" VCR (1st Cassette)	
1971	Ampex Quad Super High-Band	*Sony 3/4" U-Matic	
1973		IVC 2" Helical	
1975		Bosch 1" (SMPTE B)	Sony Betamax
1976	Sony 1"		* JVC VHS
"	Ampex 1"(A Format with Slo-Mo)		
1978	*Ampex/Sony 1" (SMPTE C)		
1983		Panasonic M	
1984		Sony Betacam	8 mm
1986		* Panasonic M-II	
1987		* Sony Betacam-SP	
"	* D1 <sup>1</sup>		* S-VHS
1988	* D2 <sup>2</sup>		ED-Beta
1989		* Hi-8	
1992	* D3 <sup>2</sup>		
"	* DCT <sup>1</sup> (Compressed)		
1993	* D5 <sup>1</sup>		
"	* Digital Betacam <sup>1</sup> (Compressed)		
1995		* DVC <sup>1</sup> (Compressed)	

\* In common use in 1995

- Notes:
1. Component Digital
  2. Composite Digital
  3. The dates are when the product was first publically available.
  4. In the years 1962-1975, about 30 to 40 Industrial/Educational formats came and went. Only the more popular formats are listed here.
  5. All formats are Helical except when noted as Quad (1956-1971)

# TAPE ARCHIVAL & RESTORATION SERVICES

**Statement by Jim Wheeler before the Library of Congress Panel  
The Current State of American Television and Video Preservation  
March 6, 1996**

I have two recommendations to help preserve America's television and video heritage. One of them is intended to mitigate the effect of rapidly changing equipment technology, and the other is intended to help archivists select tape with long life expectancy.

But first, I will give you a very brief history of videotape recording to illustrate how **fast** this technology has changed in just 40 years. I have first-hand experience with the development of videotape recorders because I joined Ampex just five years after the first Ampex videotape recorder was introduced. For 32 years, I specialized in two fields: I was both a tape recorder design engineer and a tape engineer.

## **1. Brief history of videotape recording**

Several companies tried to develop a videotape recorder in the early 1950's but Ampex was the first to succeed. The Ampex VR-1000 was introduced in Chicago at the National Association of Radio and Television Broadcasters Conference on April 14, 1956. At that NAB Conference, Ampex sold 90 machines at a cost of \$50,000 each for a total of \$4.5 million. Ampex marketing had forecast only 30 machines over a four year period.

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The first on-air broadcast of videotaped material occurred on November 30, 1956 with the CBS Douglas Edwards evening news broadcast. The show was time-delayed by using videotape recorders in each time zone. The large reels of 2" tape were very expensive, so each tape was rerecorded over and over again. Another problem with the early videotape recorders is that tapes could be played only on the machine that had recorded it. Tapes could **not** be interchanged between tape recorders.

Until 1964, the use of videotape was limited because editing of videotape was done by the extremely labor-intensive process of physically cutting and splicing. In 1964, Ampex introduced an electronic editor and also color videotape recording. These innovations expanded the use of the videotape recorder to new areas, such as, TV commercials.

Also in 1964, Ampex introduced a portable videotape recorder which had a slow motion/stop action feature--later referred to as Instant Replay. ABC bought six of these units and Wide World of Sports than became a big success.

In 1968, Sony introduced the first videotape recorder that was small enough and cheap enough for use in the field of education. This was a 1/2" reel-to-reel machine. It was replaced by the Sony U-Matic cassette recorder in 1971. The 3/4" U-Matic became very popular for use in Education and also for Industrial applications. It is still used 25 years later.

The videotape recorder was not cheap enough for the consumer until Sony introduced the BetaMax in 1975. The following year, JVC introduced the VHS VCR, and the battle of the formats began. By 1985, Japan was producing over a million VCR's each month.

In 1989, Sony introduced the Hi8 camcorder. This recorder, with its 450 line resolution, was cheap enough for consumers, yet the high quality made it usable as a field camcorder for news gathering.

**Digital** videotape recording was born when SMPTE established the D1 standard in 1987. Digital has a major advantage over the previous analog based recorders because there is no degradation when tapes are copied. It is difficult to differentiate a camera original from a multi-generation digital copy.



## **2. Equipment Obsolescence**

All in all, there have probably been about a hundred videotape formats introduced over the 40 year history of the videotape recorder.

The main problem with using rapidly developing technology, like videotape recording, is that new developments quickly make equipment obsolete. Eventually, your favorite tape recorder will no longer be produced, and, in a few years, it will be difficult to find someone who can maintain it.

For this reason I am recommending the creation of a repository for old videotape recorders--a retirement home. Such a National Video Center could also be a repository for literature and technical manuals for the equipment. This Center could maintain a database of the location of other equipment and of technicians who know how to repair the equipment.

## **3. Monitoring Tape Durability**

The second problem I am addressing today is degradation of tape binder. This problem makes it necessary to store tape in a cool and dry environment to maximize its longevity. In a high humidity and/or high temperature environment, the tape binder hydrolyzes and breaks down.

In recent years, most tape manufacturers have changed to a much more stable binder, but who knows which of the many tapes have the stable binders? Tape manufacturers will not publicize what type of binder is used in each product or how stable the binder is.

What we need is a National Test Laboratory that will publish test results annually -- sort of like the Consumer Reports' Annual Auto Guide. This lab would develop tests that are indicators of the durability and longevity of each type of tape on the market. With this information, Archivists would know which tapes to purchase and which recordings in their collection need to be copied to tape with a more stable binder.

This test lab could be the National Media Lab (NML) in St. Paul or the NIST in Washington, D.C..

In my opinion, we need both a videotape recorder repository and a videotape test laboratory to insure the longevity of our Television and Video Heritage.