# AMIA Tech Review
From the Association of Moving Image Archivists


## Editor's Note

My plan for this issue was to have an intense investigation into both the major studios' and television networks' plans for long-term preservation of electronically finished programming, whether originated on film or electronic media. Unfortunately it appears this idea was well ahead of present reality and could not be easily covered at this time. MORE


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August 23-25, 2012
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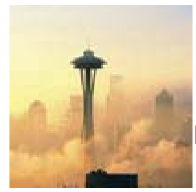

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## CONTRIBUTING AUTHORS


Andy Maltz
Andrew Oran
Vince Roth
Milt Shefter
Linda Tadic


## UPCOMING EVENTS

| | |
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| May 16-19 | ARSC Conference |
| Aug 23-25 | The Reel Thing: Los Angeles |
| Sept 23-25 | Memory of the World in the Digital Age Conference |
| Sept 28-Oct 1 | FIAT/IFTA Conference |
| October 26-27 | AES Conference |
| October 19 | DAS 2012 |
| Dec 4-7 | AMIA Conference: Seattle |

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# Editor's Notes

By Ralph Sargent

## In Memorium, Alan Stark

As many of you may already know, Alan Stark died on September 20th of this past year and this accounts for us missing the Fall, 2011 issue of the *Tech Review*. Alan was well known as a lifetime member of AMIA, member of the Board of Directors, Treasurer of the organization and chair of the Development Committee. Less well known was his role as a member of the Board of Advisors to this publication. It was Alan who designed the "look" of the *Tech Review,* how its various parts and features would be handled and its visual style. He was also a careful and wise proofreader. When I'd draw a blank on how to deal with a difficult editorial matter, his rewrite suggestions were always on the mark for both clarity and comprehension.

Alan is sorely missed by the AMIA staff and membership as well as the staff of Film Technology Co., Inc. where he was Vice-President and, along with myself, co-owner. His business acumen, friendly demeanor and wise counsel were necessary ingredients to the success of both organizations. This issue of the *AMIA Tech Review* is dedicated to his memory.

## This Issue

My plan for this issue was to have an intense investigation into both the major studios' and television networks' plans for long-term preservation of electronically finished programming, whether *originated* on film or electronic media. Unfortunately it appears this idea was well ahead of present reality and could not be easily covered at this time. Instead, two articles in this issue aim to establish a foundation for future articles and may result in opening some eyes as to what is required to reach the goal of 100 year media specifically designed for long-term digital storage.

A third article is an excellent review on Color Space by Andrew Oran and Vince Roth. This is a topic with which many people "freeze up" just hearing the subject being announced. Fear not, for once you'll read a clear and understandable explanation of the topic and its importance.

Also, a reprint of a *Science and Innovation* article published in August of 1929, just two months shy of what *Variety* called the day "Wall Street laid an Egg." In this case, we're not concerned with "Black Friday," but the 100$^{th}$ Anniversary celebration of Paramount Pictures via the Blu-ray release of "Wings," the very first film to win an Academy Award for Best Picture. A visually stunning restoration of the picture, two optional scores – orchestral and theater organ – and a lively recollection of the production of the film round out the disc. The *Science and Innovation* article concerns itself with how the aerial combat portions of the film were shot and how the stunts were performed. A broken neck or two were needed to make things look real!

Finally, I'd like to urge you to read the January/February 2012 issue of the *SMPTE Motion Imaging Journal* and most especially the article entitled, "Application of Data Storage on Cinematographic Film for Long-Term Preservation of Digital Productions." This proposal, and possibly a modern interpretation of Kodak's Dots system may well be the basis for the wished-for medium discussed earlier in these remarks.

**And now, the boilerplate:**

Those of you who feel you have appropriate material to contribute, please feel free to advise us via a thematic proposal or précis of your article. If accepted for publication, your articles should be received at the AMIA office no later than six weeks prior to next publication date. (Please email Laura Rooney at the AMIA Office for anticipated publication dates.) All articles or suggestions submitted are subject to review, condensation or augmentation and editing.

Publication of the *AMIA Tech Review* is web-based in portrait format. The print version is found as a PDF. Readers are encouraged to print whatever they wish ***for their own use***; however, all material shall remain the copyrighted property of the Association of Moving Image Archivists or respective copyright holders as indicated and may not be reproduced for any other use in any form without the prior express written permission of the Association or indicated copyright holder.

We encourage readers of the *AMIA Tech Review* to become members of ancillary trade associations such as the National Association of Broadcasters, the Audio Engineering Society, the Society of Television Engineers, the Society of Motion Picture and Television Engineers, etc. Cross-pollination of technical information is important and we strongly support it!

Finally, please let us know what you think. It never hurts to speak your mind in a civil and constructive manner. If there is some aspect of this publication you feel could be improved, please let us know. If there is something you liked, let us know. You get the idea….

Best wishes,
Ralph Sargent, editor

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# Video Preservation for the Millennia

By Linda Tadic, Executive Director, Audiovisual Archive Network

In the area of Dunhuang along the Silk Road in China's Gobi Desert are over 700 caves carved out of mountains by Buddhist monks. These caves, created between the 4th and 14th centuries AD as acts of devotion, are covered with incredible mural paintings depicting Buddhist sutras, details of daily life such as farming, dances, and ceremonies, and iconographic images from many of the world's religions: pagan Chinese, Buddhist, Hindu, and Christian. Some cave walls even include graffiti from Russian soldiers imprisoned in the caves in the 1920s.

The caves are managed and conserved by the Dunhuang Academy, which since 2000 has been creating high resolution digital photography and video documentation of the cave murals. The Academy is in an unending struggle to conserve the caves, which are a UNESCO World Heritage Site. Several caves collapsed over the centuries, succumbing to the sand, wind, and elements. The Academy knows that in 1,000 years, the digital photography could possibly be the only remnant of some caves and are developing a digital repository for the images, video, and data created. The digital files must be preserved as carefully as the caves themselves. I have been fortunate to work with the Academy in developing the requirements for their repository, and have been struck by how their experience parallels those of archives with videotape collections. While video has not existed for 1,500 years, the problems in conserving documentation of the caves and content captured on video are the same.

*The Digitization Imperative*

By the time today's moving image preservation students reach their 25-year career mark (if not sooner), videotape will have ceased to exist. Not only will the manufacture of videotape have ended as the world completes its shift to file-based production, but most of the legacy videotape held in archives will no longer have a retrievable signal to transfer. Like a Dunhuang cave that could be subsumed by the elements, the content on those videos fortunate enough to have been digitized will survive as digital files; in essence, the video content is "re-born" as a digital file, and it is the digital file which must be preserved for the future. With video, archivists have had to shift their focus from preserving the medium to preserving the content on it.

Videotape was never intended as a long-term storage medium. Its inherently short life expectancy (LE) required archives in the pre-digital era to periodically migrate from one video format to another in an effort to prolong the content's existence. Compounding the repetitive migration problem was video format obsolescence, which every archive with video has experienced. Twenty years ago, transferring to Umatic was the standard operating procedure. Umatic, now an obsolete format, was followed by BetaSP as the standard target analog format. BetaSP is now obsolete. Archives began transferring to Digital Betacam, but while the media holds a digital signal, the content is still on videotape with its inherent deterioration issues; the file must be extracted from the tape and treated as a digital file. In addition, archives are beginning to consider DigiBeta as the format next in line to become obsolete. Its high definition (HD) sibling, HDCAM, is commonly used by broadcasters and studios for HD content, but again this is a videotape-based format. The HDCAM tape shortage caused by the March 2011 earthquake and tsunami in Japan acted as a "wake up call" for content creators to stop delaying the inevitable and make the move to medialess production.

*Target preservation digital format?*

With video's format obsolescence, short life expectancy issues, and the impending death of video as a viable medium, content creators and caretakers of all types are recognizing that they must adapt their production and archiving workflow from analog to digital. Content is being created digitally ("born digital"), and analog videos are being digitized as funds allow.

The process of transferring legacy obsolete video formats to soon-to-be-obsolete video formats is in danger of being replicated in the digital realm. Transferring to digital codecs or formats that can possibly become obsolete in the future is not a good model to follow.

One of the most contentious topics in our field is what should be the standard target preservation digital format when transferring analog tape to digital files. Some believe that there cannot be one standard appropriate for all analog source video formats and for all archives; instead, we should focus on using an open format for easier future migration and consider the organization's infrastructure and ability to preserve the digital files.

In selecting a target format, one must weigh file format sustainability factors such as those outlined by the Library of Congress.[1] The basic rule of thumb is that the preservation format should be:

- An open standard (not proprietary; this includes file wrappers as well)
- Well-supported (strong hardware and software support)
- Well-documented (required so validation and other tools can be created to check the file)

Ideally, the file should be as uncompressed as the archive can manage. Using an open format with as little compression as possible will help an archive migrate the files forward in the future. Low or no compression is also more forgiving of bit loss, whereas bit loss in a highly compressed format can result in lost information or even a corrupt and unplayable file depending on where the loss occurred in the file.

The **open standard** requirement means there are few file formats or codecs from which to choose for analog-to-digital conversions. The most common is uncompressed (YUV 10-bit), followed by JPEG2000. While DV25 is compressed 5:1, it and DVCPRO50 (3:1 compression) are sometimes used when transcoding VHS tapes or by archives with such large video collections that their infrastructure could not support encoding everything as uncompressed.

Sustainability factors for wrappers such as MXF (an open format unless proprietary information is added to the header) and the two proprietary wrappers QuickTime and AVI must be weighed just as much as a codec or format. The Federal Agencies Digitization Guidelines Initiative **(**FADGI**)** is drafting an open MXF Application Specification for Archiving and Preservation (AS-AP)[2], and the result of the group's work is eagerly awaited by the archival community.

*Long-term storage*

In choosing a preservation digital format, the organization must consider its infrastructure. Can the organization support the digital storage, staff time in migrating and checking the files every set number of years, and upgrading hardware roughly every five years? We hear that "storage is cheap," but storage itself is only one part of the ongoing digital preservation costs. Before selecting a target preservation format, an archive must estimate the amount of storage required for at least five years' growth, as well

[1] http://www.digitalpreservation.gov/formats/sustain/sustain.shtml
[2] http://www.digitizationguidelines.gov/guidelines/MXF_app_spec.html

as human labor and infrastructure costs. Infrastructure can include hardware, software, electricity, air conditioning, physical space, and backup generators.

There is no “store and ignore” media for digital files. Digital preservation requires constant managed actions to migrate forward both the storage media and the file format itself should it become obsolete. This work must be done regardless of the storage medium used: external hard drives (HDD), RAID servers, a Storage Area Network (SAN), or digital tape such as LTO. Larger organizations often use a mixture of storage strategies, for example using a SAN with automated LTO backup. Smaller organizations tend to use HDDs or standalone RAID servers, but it is becoming more common for them to also make LTO copies for backup using single-slot LTO drives. None of these are perfect solutions, so an organization must research and understand the pros and cons and the work involved with each storage solution.

A SAN with automatic LTO backup can involve higher costs upfront for hardware and infrastructure (electricity and AC) with lower staff costs for ongoing maintenance. A smaller operation utilizing HDDs or a RAID attached to a single-slot LTO drive will have lower initial hardware and infrastructure costs, but be higher on labor since the backup process might not be easily automated. Additional considerations in using LTO as a back-up medium is that the tape is manufactured to be two generations backwards “read” compatible, and one generation backwards “write” compatible. This means that LTO3 tapes may be read on today’s LTO5 decks (but not written to), but LTO2 tapes cannot be read or written to; LTO2 is an obsolete digital tape format. Thus, an archive using LTO is obligating itself to upgrade hardware every two generations (approximately every 5 years). There is also the issue of back-up software, which writes and catalogs the files to tape so the files can be retrieved. If an archive sends content to a vendor without specifying which backup software they use, it is possible that the vendor could return the LTO tape with their transferred content using a backup/cataloging software that is not readable by the organization. LTFS (Linear Tape File System) is a setting now available on some LTO5 decks that makes LTO tape behave like simple file storage on a hard drive; this is a promising development in removable file storage.

External hard drives (HDDs) should also be refreshed every 3-5 years. HDDs are an inexpensive storage medium for smaller archives, but are notorious for failure between 3-5 years of use. Just as files on LTO tape must be migrated every two generations, files on HDDs must also be migrated to new devices every 3-5 years.[3]

*Content protection*

Regardless of the long-term storage implemented, a digital preservation strategy or plan must be enacted for content protection. At its most basic, the preservation plan should include capturing data on file creation at the very beginning of its lifecycle, file fixity checks (checksum), redundancy and geographic dispersal, and scheduled storage migration (with file format migration as formats become endangered or obsolete).

The **file creation information** is called technical metadata; this can be used to preserve the file in the future. Everything about creating the file must be captured: the hardware and software used if it was an analog-to-digital transfer, or the camera/device used if it is a born digital file; the technical characteristics of the file (codec, format, version, size, etc.), and the environment in which the file can be rendered/played (e.g., which browser version, which software program and version, etc.).

The **file fixity check** is performed through a checksum. A checksum is created when a file is first born, and is run to check for bit loss every time a file is transmitted from one storage device to another. The checksum creates an alphanumeric string that is unique to that file; if the checksum does not match after transmission, then the file has been somehow corrupted. The most common checksum algorithms are MD5, SHA-1, and SHA-2. MD5 is the most common checksum but is now considered the least secure, so many organizations are moving to SHA-1 and SHA-2.

The most important act in digital preservation is **geographic dispersal** of multiple copies **(redundancy)**. A file can be corrupt on one LTO tape or HDD, but is fine on another. Storage devices are not infallible: a tape can be creased or warped, the drive on a HDD can be damaged by fine particulate matter or from vibrations.  If an organization can afford it, three copies are recommended but at a minimum there should be two. A redundant copy does not mean one copy is in the basement and the other on the 3rd floor; it means the copies are placed far apart from each other. If a fire destroys your building, your

[3] See Google's study on hard drive failures. Pinheiro, Eduardo et al. "Failure Trends in a Large Disk Drive Population." *Proceedings of the 5th USENIX Conference on File and Storage Technologies (FAST'07),* February 2007.

content would be safe at other facilities, say in Colorado and Pennsylvania. Archives could have cooperative arrangements where one archive stores backup copies for the other and vice versa; this storage would have to be secure so there is no risk that the copies could be stolen or damaged.

**Migration** to new storage media should be scheduled every 3-5 years, depending on an organization's choice of storage medium. The larger the file, the longer it takes to retrieve the file from storage, check it, and copy it to a new storage device. If proprietary file formats/codecs are used rather than open ones, the obsolescence arc of that format must be watched so the archive can migrate the file format forward as necessary. An archive's database should track the codec and wrapper of every file so reports on endangered or obsolete formats can easily be run. All of these migration actions must be tracked through metadata.

*Metadata*

Human labor can be the most expensive component of any digital preservation strategy, and part of the human labor is metadata creation. The previous section described digital preservation actions, and metadata must be created to track every one of those actions. Much of technical metadata can be automatically extracted from a file, but a human must input the majority of descriptive information, details on how a file was created and migrated, and intellectual property rights.

The core components of a metadata record are: descriptive (what the content is about and who was responsible for creating it), rights (who owns the rights to the overall work, and what are the underlying third-party rights), technical, and preservation. There are data structure standards for descriptive, technical, and preservation metadata from which an organization can choose relevant fields. No longer is there one over-arching data structure such as MARC; today, an organization chooses the fields from various standards most relevant to their collection and creates a data dictionary incorporating the fields. A data dictionary includes a map between the various standards for interoperability with other collections and future data migrations.

Data structure standards useful for video can range from basic (Dublin Core), broadcasting-oriented (PBCore and EBU Core), film archives-specific (CEN 15744 and 15907[4]), film delivery-oriented (SMPTE

[4] "CEN" stands for Comité Européean de Normalisation

DMS-1), and of course there is still MARC. Technical metadata standards include SMPTE's RP-210, and PBCore and EBUCore's technical metadata set. Digital file preservation metadata is only represented by PREMIS; this is a format-agnostic standard. An organization should try to create as granular[5] a data structure as possible for easier future data migration; it is inevitable that data will be migrated to new systems several times over decades.

Controlled vocabularies (e.g., set terms for subjects, names, and places) should be used to ensure the data is consistently described and content can be easily retrieved by users. Controlled vocabularies can take the form of simple "pick lists," thesauri, hierarchical taxonomies, and synonym rings.[6] If an organization does not use a standard controlled vocabulary, it should create an internal one. The key concept is to be consistent.

In the digital asset lifecycle workflow, metadata creation tends to be performed by more than one person. One staff could add basic descriptive metadata at the beginning of the asset's lifecycle, another will add technical metadata, another add rights information, and the library/archive will add preservation metadata and perhaps controlled vocabularies. Utilizing several staff to create metadata can alleviate the workload, but smaller organizations often have just one cataloger/metadata librarian.

*Time*

Archives know the clock is ticking against them and much video content will inevitably be lost. They make hard decisions on what they can afford to transfer in terms of file storage and ongoing preservation actions. To save at least some representation of the content, some archives feel that making highly compressed copies are better than not transferring the video at all. Video preservation is a complex process, and to ensure that video-based content will last as long as the Dunhuang caves,

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[5] "Granular" in a data context means there are discrete fields holding specific information, rather than one field containing several data elements. For example, using separate fields for "format," "running time," and "manufacturer stock" instead of compiling all three elements into one "note" field will facilitate mapping the elements to a new database.

[6] For guidance on creating controlled vocabularies, see: National Information Standards Organization (NISO). *Guidelines for the Construction, Format, and Management of Monolingual Controlled Vocabulary*. ANSI/NISO Z39.19-2005. http://www.niso.org/kst/reports/standards?step=2&gid=None&project_key%3Austring%3Aiso-8859-1=7cc9b583cb5a62e8c15d3099e0bb46bbae9cf38a

video archivists must become digital preservationists. We are experiencing not just a shift in how to preserve video content, but also a shift in our skills as preservationists and archivists.

**Glossary**

**MXF (M**aterial E**x**change **F**ormat). This is a SMPTE standard (*SMPTE ST 377-1:2011, Material Exchange Format (MXF) -- File Format Specification*). MXF is a container or wrapper format that can hold several bitstreams such as video, audio, and XML. Uncompressed YUV and JPEG2000 files are supported in MXF. MXF is the container for Digital Cinema Packages, and for files created on Sony XDCAM and Panasonic P2 cameras. See: http://www.digitalpreservation.gov/formats/fdd/fdd000013.shtml

**QuickTime.** Apple's proprietary container or wrapper format, also known by its file extension MOV. This is the native wrapper for Final Cut Pro editing software. Uncompressed YUV files are supported in QuickTime, but not JPEG2000. See: http://www.digitalpreservation.gov/formats/fdd/fdd000052.shtml

**AVI (A**udio **V**ideo **I**nterleaved)**.** Microsoft's proprietary container or wrapper format. Uncompressed YUV files are supported in QuickTime, but not JPEG2000.
http://www.digitalpreservation.gov/formats/fdd/fdd000059.shtml

**LTO** (**L**inear **T**ape-**O**pen). A form of digital tape that stores data. While it is magnetic media, the formulation of data tape differs from videotape. There are a few competitors in the data tape market such as DLT and AIT, but in Q1 2011 LTO had 87% market share so only this product is mentioned in this article. LTO5 is the most recent generation of LTO, and can hold 3 TB uncompressed data or 1.5 TB compressed. See the LTO roadmap: http://www.ultrium.com/technology/roadmap.html

**RAID (R**edundant **A**rray of **I**ndependent **D**isks). A server configuration for how the server or external hard drive protects files. Levels are referred to by numbers. RAID0 = no redundancy; the server or HDD is pure storage with no internal redundancy. RAID1 = files are "mirrored" (e.g., copied) from one internal drive to a second. RAID2 through RAID6 use striping and parity; for a full explanation see the Wikipedia entry here: http://en.wikipedia.org/wiki/RAID

***Sources for metadata standards referenced***

**MARC21** http://www.loc.gov/marc/

**Dublin Core** http://dublincore.org/

**PBCore** http://www.pbcore.org/

**EBU Core** http://tech.ebu.ch/docs/tech/tech3293v1_3.pdf

**CEN 15907:** Film identification — Enhancing interoperability of metadata — Element sets and structures; prEN 15907:2009 http://filmstandards.org/fsc/index.php/EN_15907

**CEN 15744**: Film identification — Minimum set of metadata for cinematographic works http://filmstandards.org/fsc/index.php/EN_15744

**The SMPTE standards** can be acquired from the SMPTE site: http://store.smpte.org/

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**Mav. 2012** | Issue 4

# Color Space Basics

By Andrew Oran and Vince Roth

## Introduction

A basic understanding of **Color Space** is critical when navigating our multi-platform, analog/digital world. Even when all of our display devices are one day digital, variations in digital display and digital projection technology will necessitate cross platform compatibility. This, in turn, will (and already does) involve the mapping of color values from “space” to “space”, to preserve an image’s intended appearance in settings as different as a darkened theater, a home living room, and a well-lit office work area. What follows is a re-presentation of some of the images and words compiled for the August 2011 Reel Thing event in Hollywood, when we took on the task of better understanding – on behalf of laymen everywhere - what had heretofore been an elusive topic, best left only to experts: Color Space.

## Color Space - what it is *not* (for the purposes of our discussion)

Colorful Space Images

Images of Colorful Spaces

**Color Space - what it *is:***

- A combination of a color model *plus* a precise description of how the colors within that model are to be mapped in 3D space, allowing for specific colors to be identified by coordinates with a given color space.
- Examples include: CIE XYZ, CMYK, HSV, RGB (there are several RGB color spaces, such as sRGB, Rec. 709 and DCI P3).

All color perceptions have 3 dimensions: lightness, hue and chroma. The term Color *Space* implies dimensionality for good reason; a 3D space is required when mapping these 3 dimensions of color. There are too many variables at play to map all color permutations – the near limitless variations created by the interplay of lightness, hue and chroma - on a 2D plane alone.

**Some Basic Terms:**

- **Color Model:** A mathematical representation of color, based on 3 or 4 values (i.e., RGB or CMY and luminance, often represented as Y or K).
- **Color System:** Ditto!
- **Color Gamut:** A subset of colors which can be represented within a given color space or by a particular output device.
- **Chromaticity:** The quality of a color separate from its luminance, determined by hue and saturation alone.
- **Visual Spectrum:** The colors we can see.

The terms **Color Model** and **Color System** - as well as **Color Space** - are often used interchangeably, and, as far as I can determine, with little risk of fine or misinterpretation. We'll stick mostly with Color Space for this discussion. **Color Gamut** is a limited range of colors within a color space, and a term often used in relation to film's color space (or gamut). **Chromaticity** is color value regardless of luminance, or brightness. And the **visual color spectrum** is, well, all around us: it's what we can see.

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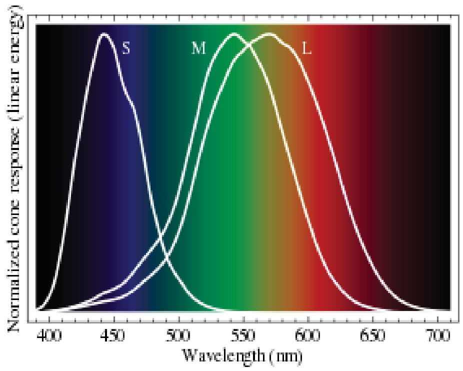
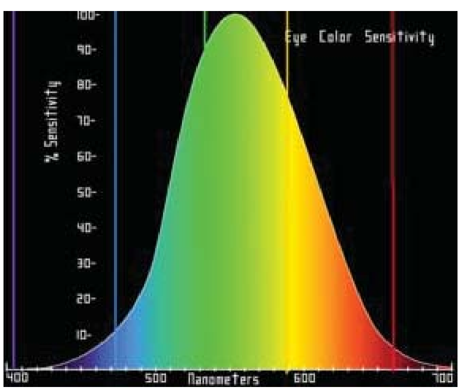
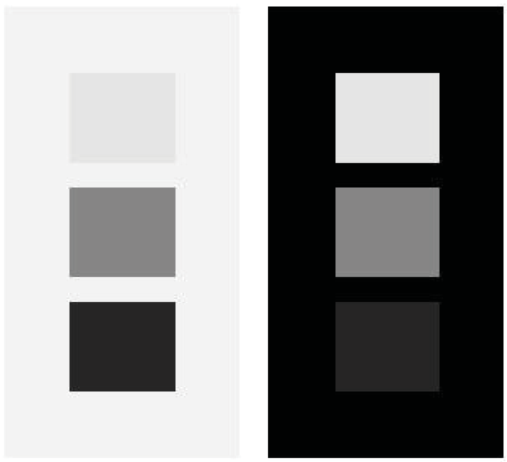
**Human Color Response:**




It all starts with our ability to see color. It's estimated that we can distinguish 10 million colors. The S, M and L on the chart above refers to Short, Medium and Long color wavelengths, which correspond to Blue, Green and Red cones – or receptors – in our eyes. When the number and combined receptivity of our receptors are factored together (for each color cone varies in sensitivity), we see – in the diagram below – that we are attuned most of all to recognize the color green.



**The "Surround Effect" (or Human Contrast Response):**



The diagram pictured above, which first appeared in a 1989 *Physics Today* article, helps to illustrate the way in which images viewed in a *dark* or *dim surrounds* will impact the intensity of the displayed scene. *Dark surround* images will appear lacking in contrast, as our visual system's contrast range contracts or adjusts in response to the dark setting. This helps to explain why film intended for viewing in a dark surround setting is designed and processed to have a gamma greater than unity (greater than 1), so that the contrast range of the scene is expanded upon display. Video signals are coded similarly, taking into account a dim surround (or brighter) viewing environment.

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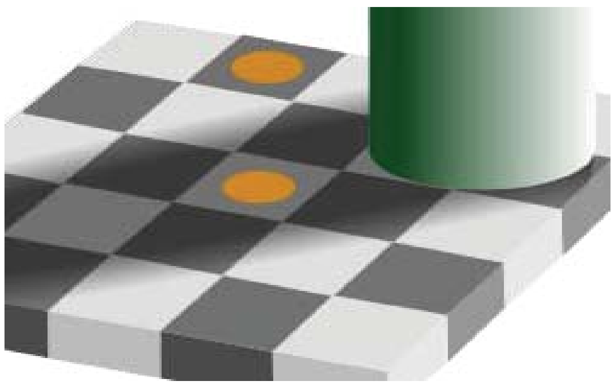

The **checker shadow illusion** pictured above, first published by Edward Adelson of MIT in 1995, is an optical illusion that demonstrates how surrounding density impacts our perception of color as well as density, in that the two orange circles are actually identical in value.

The general "take away" point of this initial set of visuals and charts is that color is a *perception* that changes based on the observer and the observer's environment. Human perception is an imperfect, moving target that defies completely objective codification (try though we might!): the human factor remains paramount amidst the calculus and geometry that defines Color Space.

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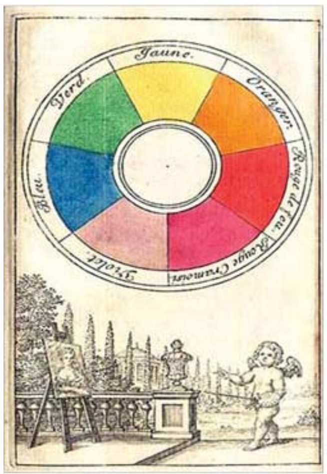
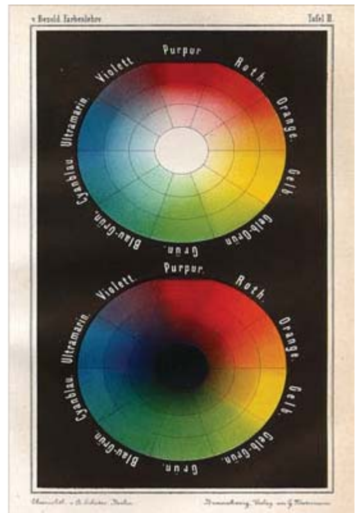
**Representing color:**

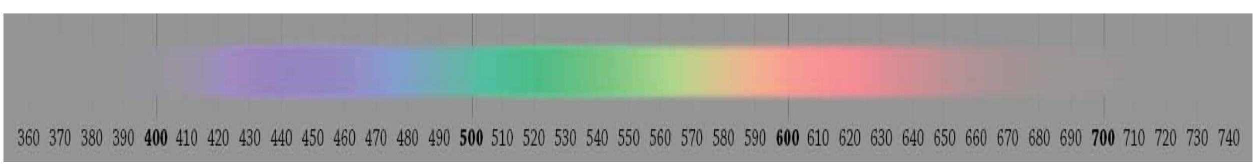


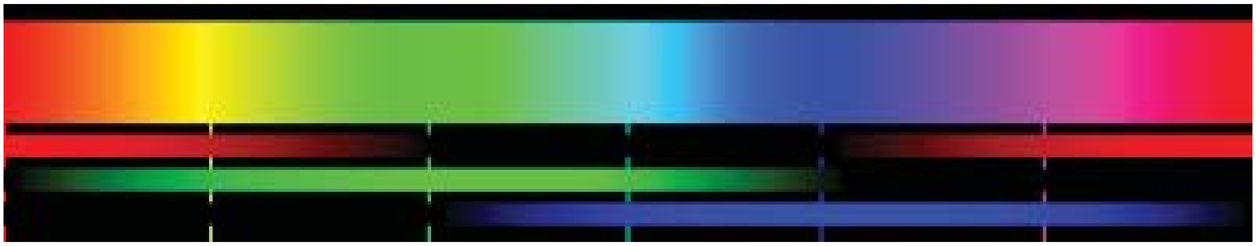

Color wheels




Representing the relationships between colors graphically dates back hundreds of years. One common variation is the Color Wheel. The German literary giant Goethe, at the start of the 19th century, is credited with creating the forerunner to the modern variation pictured at center, above, which arranges color not just in a circular pattern but also based on the relationship between the primary (RGB) and secondary (YCM) colors. You'll note Blue and Red combining to make Magenta; Green and Red combining to make Yellow; and Green and Blue combining to make Cyan. Goethe is also credited with assigning emotional associations with the color spectrum that have stuck to this day, Red being "warm" and Blue being "cool". More on this when we discuss color temperature.

**The spectrum of visible light:**

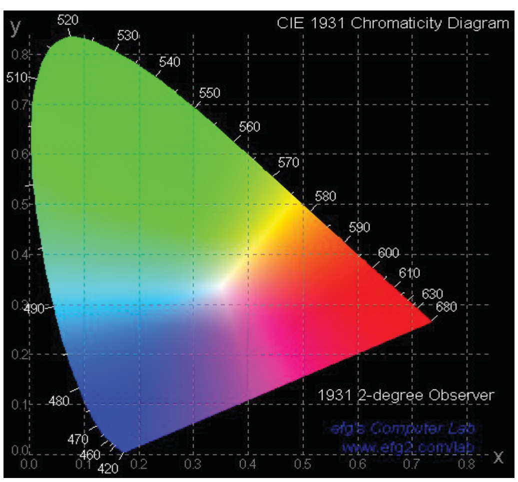




Human receptivity to light – or visible light – typically occurs in the range of 390 to 750 nm, or nanometers. Pictured here are one dimensional representations of the visible light spectrum.

**CIE 1931 XYZ color space:**

In 1931 The International Commission on Illumination (abbreviated as CIE for its French name, Commission internationale de l'éclairaget) created one of the first mathematically defined color spaces, the CIE 1931 XYZ color space.




The CIE XYZ color space (aka "the mother of all color spaces") is based on the color sensitivity of the average person as established by testing conducted in the late 1920's, wherein test subjects, using luminance and chroma controls, matched adjustable light to achieve matches to reference colors. The CIE XYZ spectrum locus, pictured above, maps the visible color spectrum along the X and Y axis - chrominance only, not luminance. It's a 2D slice of the full 3D CIE XYZ color space. Around the outside edge of the colored horseshoe are the wavelengths of pure spectral color values expressed in nanometers, with the most saturated colors at the edges, going to white in the center. CIE XYZ is an essential reference tool for color imaging that has been in use since its inception, with only minor revisions over time.

### Additive vs. Subtractive Colors:

Additive color systems start from black, and combine light of various wavelengths to create a full color image, stimulating the R, G & B receptors in our eyes (as mentioned previously). Video is commonly thought of as an additive color medium. Subtractive color systems start from white, and absorb wavelengths of color to create full color images. These systems are typically associated with film, print and textiles: emulsions, paints, dyes and inks. The following diagrams help to illustrate the difference.

**Additive colors –** Red, Green & Blue - combine to make white:

**Subtractive colors –** Yellow, Cyan & Magenta – combine to make black:

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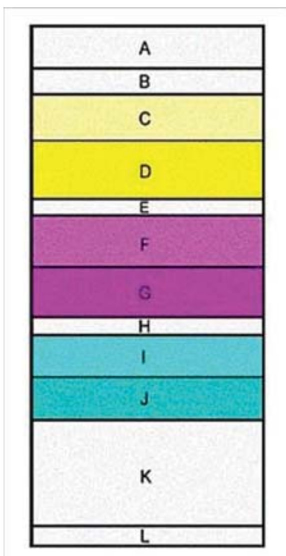
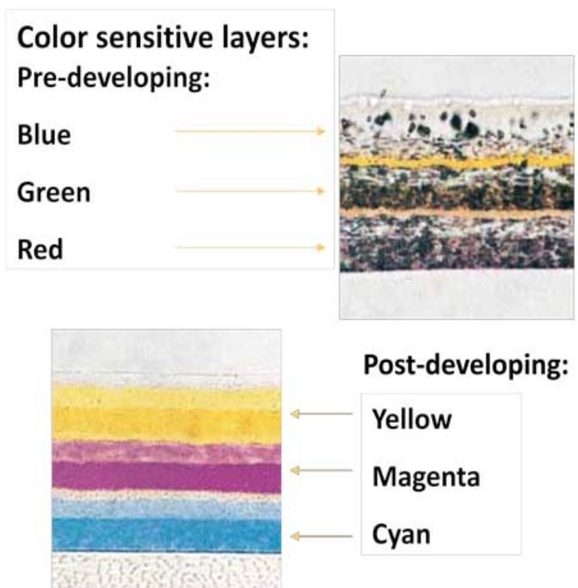
## Film color:

Enter film. Film color is typically achieved through a complex series of silver halide grain layers suspended in gelatin; in the case of color negative film, there are three layers of silver halide mixed with color couplers, as well as inter- and protective layers that filter specific light. Together these end up creating unique Yellow, Cyan, and Magenta color layers in the developed negative, and a full color image when reproduced via printing or scanning, akin to the subtractive process outlined above. Because film is subtractive, it's good at creating richly saturated dark colors. It's also an altogether incredible technology however analog it may be, dating back to the 30's with 16mm Kodachrome and the 50's with Eastman Color.




Emulsion layers of color negative




But I'm getting ahead of myself. The first color motion picture film process to achieve widespread acceptance was not single-strip, multi-color negative but 3-strip Technicolor. 1935 saw the release of the first 3-strip Technicolor feature, *Becky Sharp*. That same year Technicolor's J. A. Ball made a presentation to the Academy of Motion Picture Arts & Sciences that featured the color hexagon pictured below. The Technicolor process used a beam splitter prism to split light into its Red, Green and Blue components, which were then captured on 3 strips of black and white negative, and recombined in a printing process too complex to review here. But boy did it compliment Miriam Hopkins, star of *Becky Sharp*.

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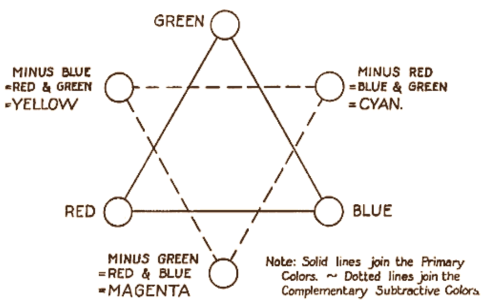
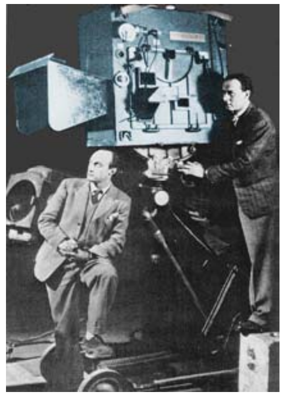
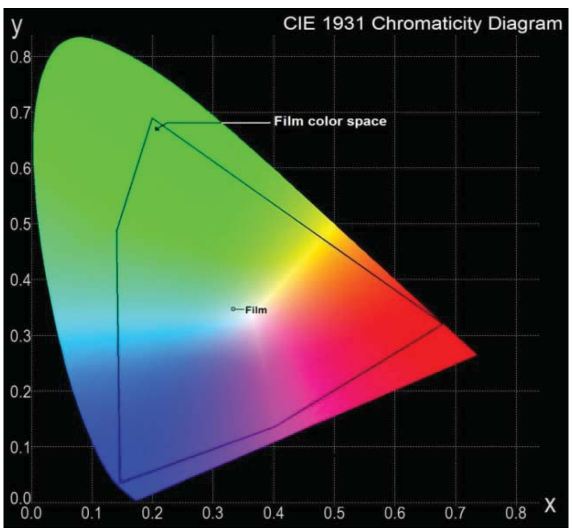


FIG. 2. Diagram showing the relation of the taking colors to the printing colors.



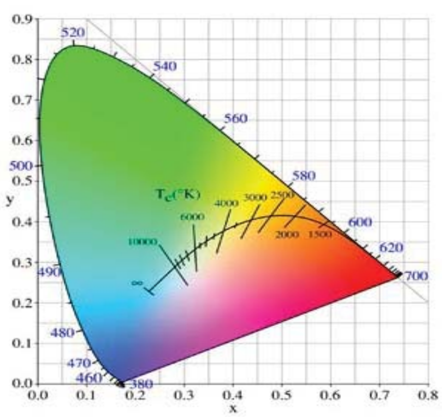
**Comparison of color spaces: film color:**

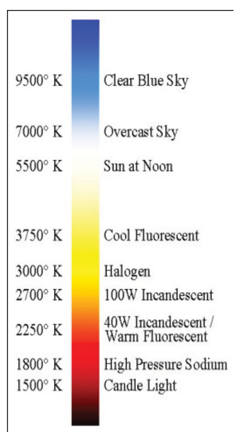



Film color is not a color space per se. There are limits, or boundaries, to what can be captured on film and reproduced via film print, and these boundaries, when mapped on our handy CIE 1931 XYZ color space chart, establish what we might refer to as film color gamut. As you can see, it's a subset of the larger area: in other words, not all colors within the visual spectrum can be reproduced via a color film capture + display system. The white point – where all colors converge to form white – is noted in the center of the diagram. The complex shape of the film color gamut is a reflection of the fact that film handles color in a non-uniform manner, creating a shifted, non-uniform triangle.

**Color Temperature:**

Every imaging system has a defined color temperature for the white point of its color space. The temperature reading are measure in "degrees Kelvin", a scale named after British physicist William Kelvin whose testing in the late 1800's recorded the color changes induced by heating Carbon, Lord Kelvin's "black body radiator" of choice.

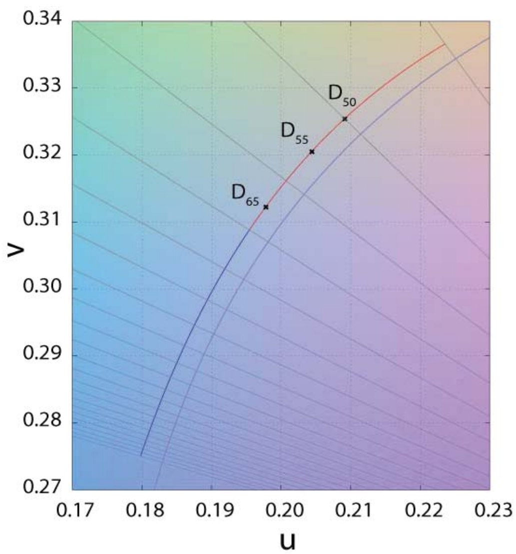



As the diagrams above indicate, lower color temperatures appear "warmer" (more Red/Yellow), while higher color temperatures (oddly enough) tend to look "cooler" (more Blue). Color temperature is an important component of a color system: as we'll see shortly, as defined white points vary so can the entire color of an image skew hot, cold, or otherwise.

**White Point:**

What's a "white point" and why should we care?! The white point of a color space is defined by it's X, Y coordinates on the CIE XYZ chart. White points are critical to the correct translation of images from setting to setting: not only due to the characteristics of light when the image was captured (from warm sunlight to cool fluorescents) but also to account for the color characteristics of the display devices used during post-production and exhibition.




The most common white points are D55 (associated with film) and D65 (associated with video and digital cinema). This labeling references degrees Kelvin – in other words, the white point of film is warmer (at D55 or 5500 degrees Kelvin) than the white point of monitors (at D65 or 6500 degrees Kelvin). D50 is a white point associated more with printing on paper.

### Rec. 709 Color Space:

**Rec. 709** Color Space, developed in 1990 by the Int'l Telecommunications Union for HD Television, is one of the "Big 3" Color Spaces - along with Film and Digital Cinema Color Spaces - to consider when mastering or re-mastering motion picture content. Rec. 709 Color Space is targeted for video work, viewed on professional broadcast displays.

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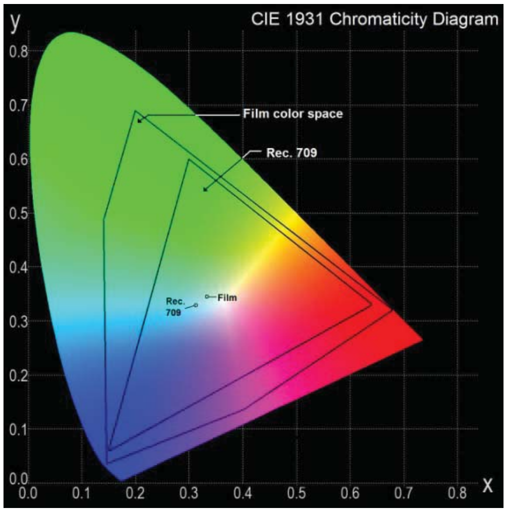



The diagram above superimposes the Rec. 709 Color Space over the CIE 1931 diagram. It, as with the other Color Spaces we've reviewed, is defined by fixed Red, Green and Blue points – the corners of the triangle, also referred to as "primaries" - a white point (D65, or 6500 degrees Kelvin), and a characteristic gamma function (in this case, 2.4).

**Gamma:**

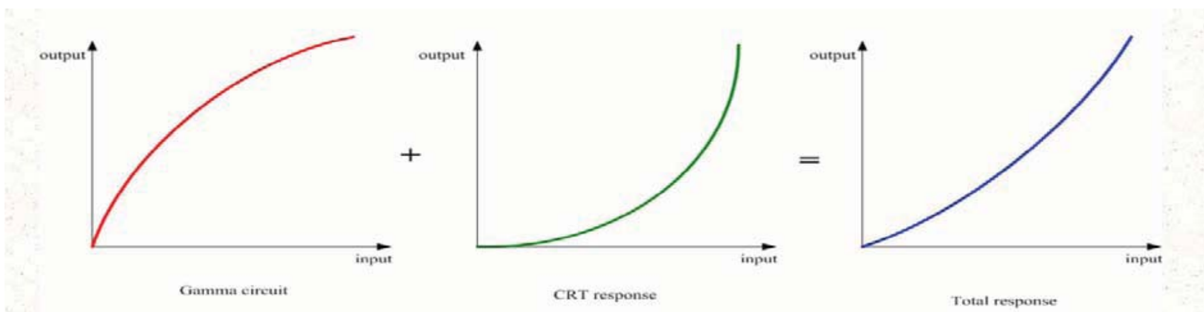
Gamma is a slippery beast. It can be described as:

1 - The numerical value of the slope of the characteristic curve of a photographic emulsion or digital camera system.

2 - A measure of the contrast reproduced in a photographic or digital imaging system.

3 - The way brightness is distributed across the intensity spectrum by a monitor, printer or scanner.

Gamma *correction* is a manipulation to the contrast of the display signal to correct for the fact that the intensity displayed on CRTs and other displays is not linearly related to the input voltage, as shown in the example below:




Gamma means something slightly different viewed from a film vs. a video perspective, as the definitions listed – which are by no means complete - suggest. For color film, we'd adopt description 1, and quantify the gamma at around 0.6 for negative, 1.0 for intermediate (to preserve the characteristics of the source negative), and 3.0 for color print (to compensate for the viewing environment of color print). For video displays, we'd adopt description 3, and quantify the gamma at anywhere from 1.8 to 2.6. Perhaps its greatest relevance is relative: because different display devices and capture/transfer media invoke different gamma, we must take gamma into account when preparing images for different viewing platforms.

## DCI P3 Color Space:

The **DCI P3** Color Space, which is larger than the Rec. 709 Color Space, was agreed upon by the major Hollywood Studios to facilitate uniform distribution content across digital cinema platforms. It's targeted for Digital Cinema, and was created to approximate the color gamut of film.

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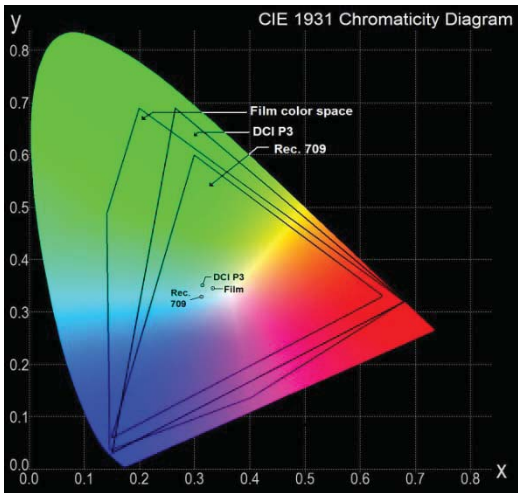
The chart below outlines the way in which the 3 common Color Spaces we've reviewed – DCI P3, rec. 709 and Film - encompass slightly different color ranges and white points within the CIE XYZ chart.




Each color space is designed for and relevant to its intended viewing technology and environment. For example, because the DCI P3 color space has more saturated primary colors than Rec. 709, images encoded for P3 look de-saturated when displayed on a video monitor.

You might wonder: how is it that the CIE XYZ color space is so large? If all colors are derivatives of R, G & B, what colors lie beyond the RGB boundaries of these common Color Spaces? The answer is that CIE XYZ color space includes primaries that cannot be said to red, green and blue, with the additional color range comprised of imaginary or non-real colors: colors that cannot be produced by a physical light source, but can be evoked by stimulation (or over-stimulation) of the color receptors in our eyes.

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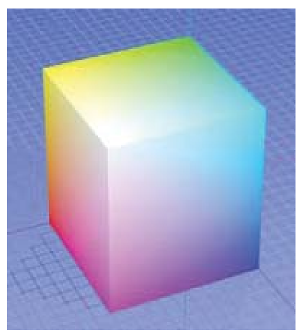
## What color 'space' might look like:

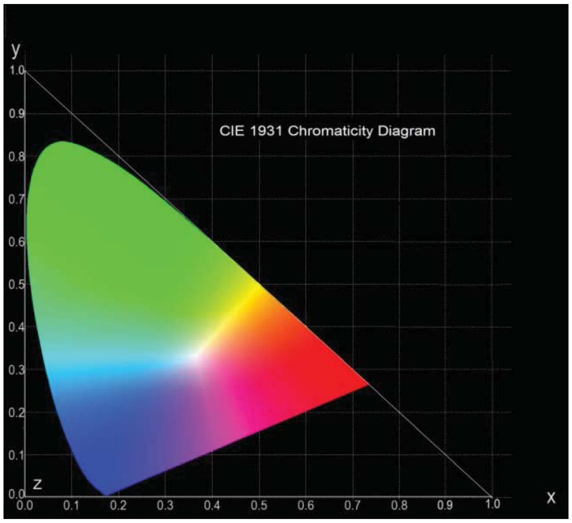
Pictured below are images of what color spaces might look like when extrapolated to 3 dimensions. Each one incorporates a complete range of brightness, or luminance for its color components. It should be noted that because film is not linear but logarithmic, it would not have the consistent geometric shape of digital color spaces, which can be represented as cubes or elongated triangles.

The CIE 1931 based image on the left shows how the chromaticity chart progresses from dark to light, though in the actual CIEW XYZ 3D model these splices actually shrink as they get darker. The cube on the right has 8 corners, RGB, CMY, and white & black (which is hidden): any color with 3 geometric values (XYZ) can be plotted in the cube's 3D space.

## XYZ color mapping for Digital Cinema:

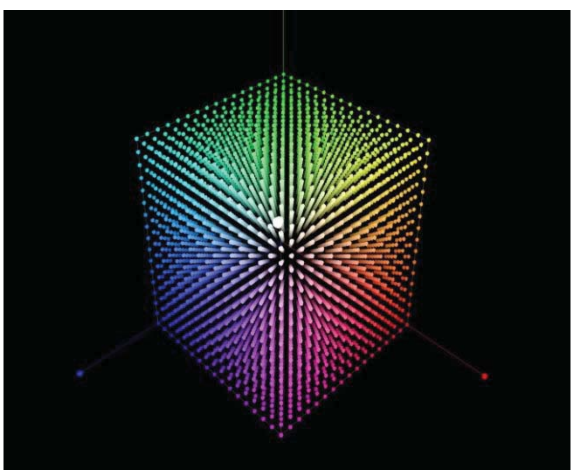
The DCI Specification (DCI Spec) sets X and Y coordinates for the XYZ color mapping (as in the XYZ TIFF files that are the show's Digital Cinema Distribution Master, or DCDM) at 1 and 1, creating a triangle that encompasses the full CIE XYZ color gamut (and then some).



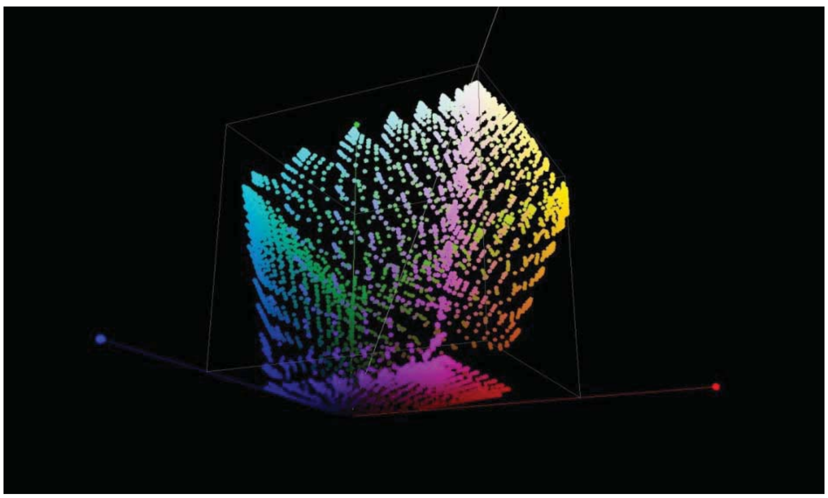

As you can see, the XYZ color container within which DCDM's reside is larger than even that described by CIE XYZ Color Space. Thank god for compression!

### 3D Look Up Table – Unity:

A Look Up Table, or LUT for short, is a 3D model of color space wherein the points - in the case pictured, a 17 x 17 x 17 point cube - are used to make adjustments from one color space to another, or to shift a series of input values to a series of output values. The model shown has no color conversion factor built into it: color passing through this LUT would not be changed.

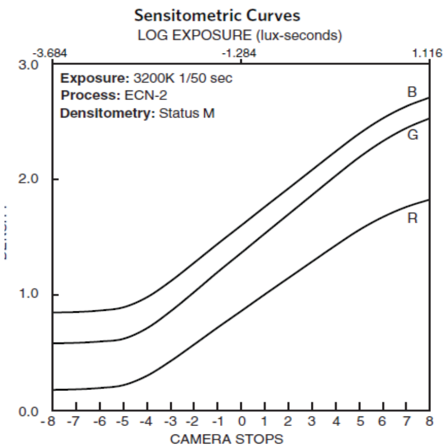


Pictured below is an example of a LUT where the color points *have* been shifted to convert an image from one color space to another, taking into account the display characteristics of the destination display system. This is particularly necessary when displaying film based (log) images on non-logarithmic display systems. As you can see, not all colors or densities track uniformly. A LUT is a delicate and quirky thing, as are the color scientists who labor long and hard to design them!

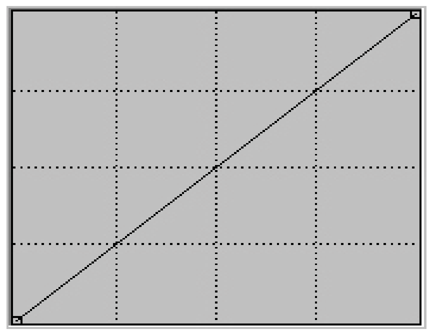


**Difference between Linear and Log:**

The following examples show how the characteristic curve of film tapers off at the top and bottom, while linear response - as in a digital sensor or digital color space - remains constant.




Kodak 5213 stock

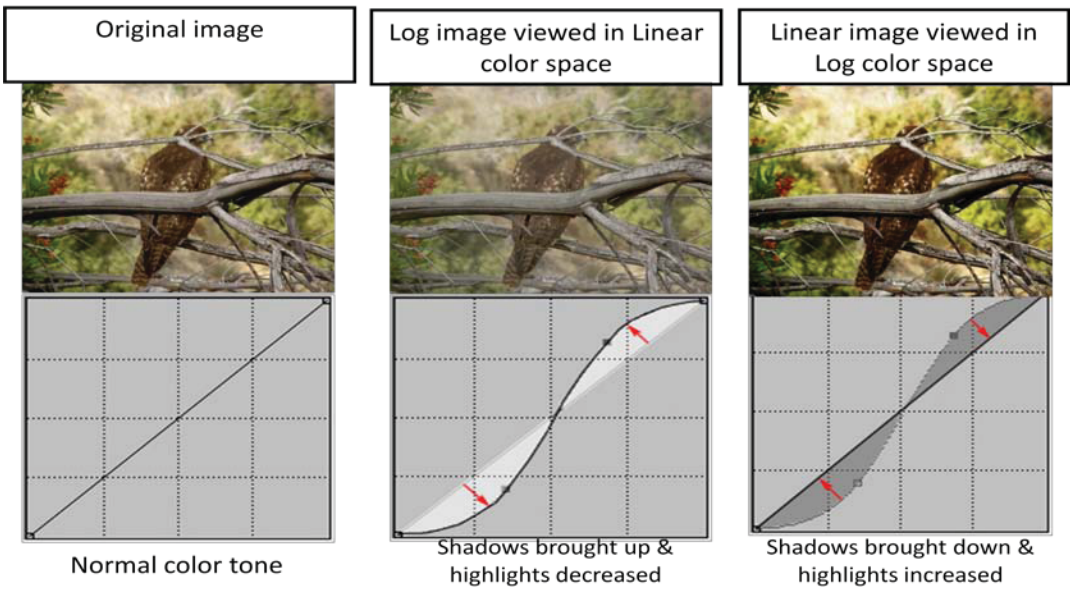


Typical response of CCD sensor

The logarithmic nature of film's exposure curve requires a "translation" – or Look Up Table - to adjust for the display realities of non-log display systems. Generally speaking, linear color systems assign equal portions of bits to describe colors in each section of the color spectrum, while in logarithmic color systems, non-uniform assignation of bits emphasize details in the white and black areas of an image. Logarithmic color mapping is a way of describing the great detail captured by a piece of film, which is highly responsive in areas of extreme dark and light.

Digging deeper into the nature of "linear" images, however, we find the term at least as complex – and as misused – as that of gamma. While linear in all cases refers to the relationship of light to image capture, there are 3 non-interchangeable kinds of linear: Video Linear (dealing with the display of light, as in video monitors, which are technically only approximately linear), Radiometric Linear (dealing with the properties or physics of light), and Sensor Referred Linear (dealing with the response of a digital sensor – as in digital camera acquisition systems – to light).

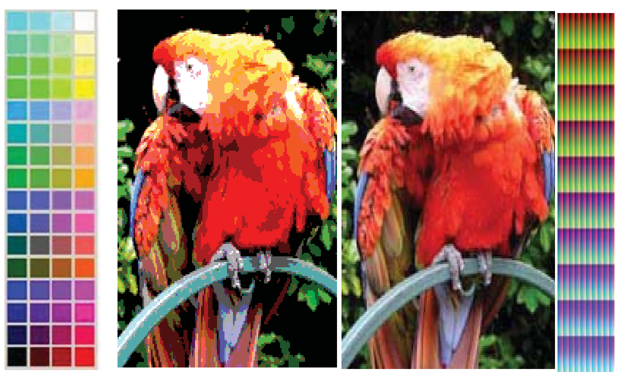
Not compensating properly when displaying film (log) images on digital display devices, or vice versa, can result in inaccurate color/density representation, as seen in the following three images:




For example, taking a log image, like one produced by a film scanner, and placing it into a linear display environment without compensation results in an image that appears flat and washed out. Conversely, a linear image viewed in log color space - without accounting for the different imaging and display characteristics of the log system - results in higher than intended contrast.

**Bit Depth:**

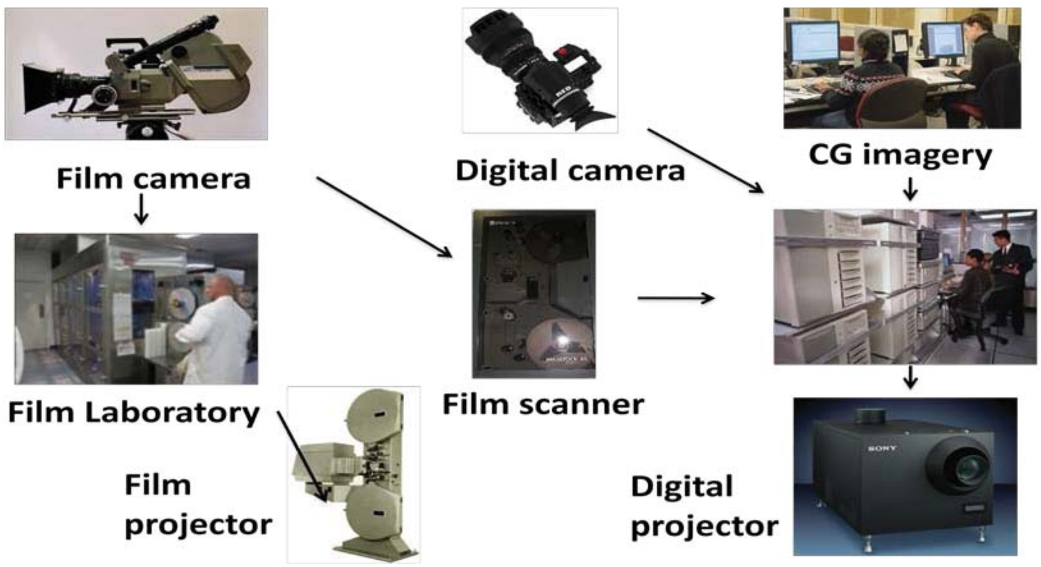
The image on the left is a 6 bit (64 color) image, while the image on the right is an 8 bit (16 million color) image. Both images have the same number of pixels, but you'll note the greater variation in detail in the image on the right.



That's because bits matter. Bit depth, though not strictly related to color space, is a key determinant of an image's fidelity. The color palette for the image on the left is 64 colors (though only 42 were used). The color palette for the image on the right is 16 million colors (though only 25,000 colors were used). It's obvious which bit depth yields a more accurate and more detailed image. A more relevant question - which filmmakers and post-production facilities wrestle with on a daily basis - is: given the nature of the source content, and the intended viewing environment of the image, how many or how few bits can we get away with?

## Imaging & Display Systems:

Finally, it's important to remember that Color Space is just one component of a larger imaging and display system that begins and ends with our eyes, but includes many devices, technologies, and above all, opportunities to do grievous harm to our images! So be careful out there.




***Thank You to:***

*AMIA, Grover Crisp, Michael Friend, Ned Price, Jerry Roskilly, Bill Schultz, Joseph Slomka, Walter Volpatto, John Daro, and the whole FotoKem DFS crew, Kevin Yuda, Wikipedia.*

# AMIA Tech Review

From the Association of Moving Image Archivists

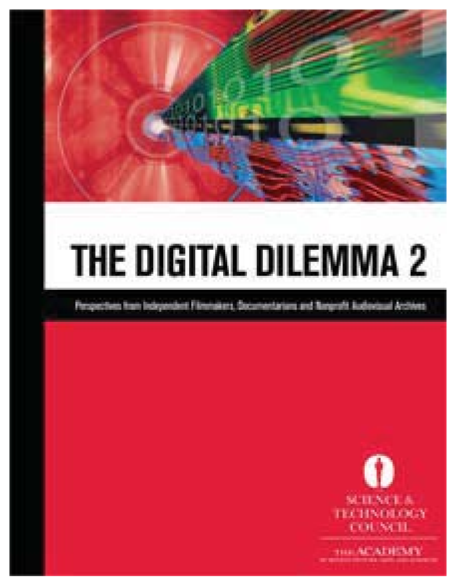
**Mav. 2012** | Issue 4


***Editor's note:*** *The Academy of Motion Picture Arts and Sciences' Science and Technology Council recently completed the second report on The Digital Dilemma. Written by preservationist and AMIA member Milt Shefter and Science and Technology Council Director, Andy Maltz, this latest report looks at the issues from the perspective of independent filmmakers and nonprofit audiovisual archives. The archives section was accomplished with the help of AMIA members Eddie Richmond and Linda Tadic, who was the lead researcher for this section.*

*The AMIA TECH REVIEW asked Milt and Andy to summarize their findings from the interviews and surveys with US archives and archivists; what follows is an abstract of "The Digital Dilemma 2."*

## The Digital Dilemma 2

Perspectives from Independent Filmmakers, Documentarians and Nonprofit Audiovisual Archives




***Forward:***

The recent selections to the National Film Registry by the Librarian of Congress included a 1912 two-reel silent melodrama "The Cry of the Children' and Charlie Chaplin's first full-length feature from 1921, "The Kid." According to Library of Congress research and the FIAF database, both of these titles still survive in the Museum of Modern Art and George Eastman House archives, among others. Now, over ninety years later, these are historic examples of long-term guaranteed access.

***Background:***
In 2007, The Academy of Motion Pictures Arts and Sciences published a report, “The Digital Dilemma,” that raised the issue of the lack of guaranteed long-term access inherent in the new digital production technologies and systems. That report covered major motion picture studios and other large organizations and businesses, and found that all had the same problem: as more and more digital data was being produced, there was no system of extending the life of that data for a period of time equal to or surpassing the life-span of analog materials, such as film.

That report focused on entities that had resources and built-in ecosystems. The Library of Congress, through its National Digital Information Infrastructure Preservation Program (NDIIPP), joined with the Academy to sponsor a follow-up report on the perspectives of independent filmmakers and non-profit audio-visual archives

Several issues highlighted in the new report may be of significant interest to archives and archivists. They are extracted and reproduced here, although for a fuller understanding of the issues affecting filmmakers and archives, it is suggested that one should read the entire report. “The Digital Dilemma 2” is now available on the Academy’s website: www.oscars.org/TDD2 .

Through surveys, interviews and a representative cross-section of archives for case studies, it is clear that there is a severe lack of resources. This includes not only funding (what else is new?) but the need for a clear definition of “archivist” in the digital world. While archivists managing analog collections require knowledge of film and audio technologies as well as library science, the new “digital age archive” also requires skills in Information Technology (IT), in digital media systems (both hardware and software) and in how to handle spinning media (hard drives) before the data it contains is no longer accessible.

If A-V archives are to fulfill their mission of preserving moving image and recorded sound for future generations, they need to address the new challenges presented by digital materials. Some archives are using digital technologies to “rescue” problematic analog titles. Others digitize analog materials for distribution. But for most archives, the hard drives that contain this important digital data merely get shelf space, and not the active management they require for continued data accessibility.

With digital materials, there is a rapid devaluation curve. Whether the digital data is financial, audiovisual or otherwise, the life of all digital content starts at the top of the curve (100% playable) and decreases to zero (non-accessible.) The time span of this curve in the digital world is just a few years, not the 100-year life benchmark used for analog items.

This benchmark is based on two distinctly different considerations: 1) analog film has a proven 100-year life when stored in appropriate environmental conditions, and 2) the minimum 95 year copyright protection period. Content creators (and their families) can benefit from their efforts for at least that period of time, assuming there's content to be accessed.

There are many anecdotal horror stories about losses of material in months to just a few years. Hard drive manufacturers generally warranty their products for five years, but that warranty covers only the hardware. Filmmaker Magazine, which cooperated in a survey of independent filmmakers on this subject, cited the experience of Tom Quinn. He spent several years making a film about the famous Philadelphia Mummers and their annual parade, and he made a DVD (compressed, of course) of the movie to show his family and friends one weekend. During the viewing, he noticed a section he wanted to re-edit. When he went back to his desktop editing system a few days later, he found his hard drive containing the original digital source material had failed. His work was gone.

It's certainly easy to make a digital movie today. Almost anyone can do it. Just look at YouTube or America's Funniest Home Videos. Digital technology lowers the barrier to be sure. It also increases competition to get seen by audience, a prime goal of virtually all filmmakers. Film festivals, which used to be the major route to distribution, offer limited opportunities for screenings. A survey of the top film festivals revealed that the average acceptance rate for screenings from submissions was under 5%. That also means many worthwhile films and documentaries may not be seen unless they make it into an archive and are preserved.

There is no system at present to harness all this creativity and save it for the long term future, although nonprofit audiovisual archives have managed to amass substantial holdings of independent films and documentaries.

According to the National Film Preservation Board, there are approximately 550 public moving-image archives in the United States and its territories, and an additional 310 archives worldwide. Surprisingly, none of these archives were mentioned as an archival destination by any of the independent filmmakers, documentarians, marketers, distributors and film festival organizers surveyed or interviewed for this report, with the exception of the UCLA Film & Television Archive and its partnerships with the Sundance Institute and Outfest.

Audiovisual archives, especially the nonprofit public archives, came into being because archivists, curators and historians accepted that moving image and recorded sound materials were as legitimate a part of society's cultural heritage as books, documents, photographs and other media. As a result, the universe of audiovisual media preservation extends well beyond Hollywood's borders. In the last few decades, it has become apparent that many of these archives have custody of films that have been ascribed "permanent" value, i.e., enduring historical and cultural significance, even if these films did not generate much revenue in theatrical release.

The National Film Preservation Act, first passed in 1988 and updated several times since, codified the importance of motion pictures "as an art form and a record of our times." The Act and its subsequent revisions established the National Film Preservation Board, the National Film Registry and the National Film Preservation Foundation (a public/private partnership), as well as articulated a national plan to preserve the country's film heritage.

"Digital preservation" from the audiovisual archivist's perspective must first begin with the basic concepts of archiving, of which preservation is just one part. Archival work requires actions such as appraisal, arrangement and description (cataloging), preservation, management and providing access.

For analog materials, preservation is an umbrella term that includes conservation (storage in archival conditions), preservation (cleaning and reformatting) and restoration (proactive work to return the item to as close to its original state as possible). The critical conservation step means essentially "do no harm." If analog materials are stored in a cold, dry environment in appropriate containers, their life expectancy will be extended with minimal human intervention. Also known as the "*store and ignore*" approach, this relatively passive strategy is not possible with digital media.

Recent definitions of "digital preservation" by professional associations stress file management and related actions. If anything, the term "digital preservation" is a misnomer. Some use the term "digital archiving," which is different from what traditional IT staff considers "archiving" (regular backup to digital data tape with or without verification steps). Others prefer "data curation," which emphasizes the active management of a digital file throughout its life cycle. Whichever term is used, preserving digital media is an active process that comprises all stages of traditional archival work and important additional actions, some of which are very complex. Some of these additional actions must be taken even before the digital audiovisual data is created – selecting file formats and storage media, for example, and considering data-handling workflows that facilitate downstream preservation. In traditional analog archiving, archivists typically face substantial backlogs of incoming materials, but they can appraise and catalog them well after they are received, because analog objects are generally able to remain in an input queue for long periods without decaying.

By contrast, digital collections must be appraised and cataloged at the time of their creation, because there is insufficient time, resources and technical information available to process them for guaranteed long-term access once the digital collection reaches the archive. The fundamental difference is that the unmanaged life expectancy of digital materials is much, much shorter than that of their analog counterparts.

Several other actions are required to preserve digital media: copying to new media and file formats ("migration"), maintaining redundancy and verifying data integrity, as well as scheduling and managing the actions themselves. A further consideration is that assessing and cataloging digital collections require specialized hardware and software tools that may vary from collection to collection, and these tools require specialized technical skills to operate. Here, the term "digital preservation" is used to refer to both reformatting (using digital techniques to preserve analog or digital originals) and preserving the digital files themselves.

***Access vs. Preservation:***

Audiovisual archives have digital materials in their holdings for one or both of the following reasons:

> ***To provide access to analog or digital materials, and to preserve content that is available only in digital form or is digitized from decaying or obsolete analog sources.***

The growth of the Internet and the public access opportunities it provides, as well as the increased monetization opportunities that come with access to archival collections, are the primary drivers of digitization of analog audiovisual materials.

Since the original analog source material is not discarded, there is no need to invest the resources required to preserve the digital copies; the digital copies can be regenerated if necessary for as long as the analog source material is accessible.

Digital files for which there are no analog source materials are handled differently: they are treated as preservation master copies and therefore must be managed according to best digital preservation practices to maintain their viability. *If preservation actions are not taken, the files become unreadable and are effectively lost.*

There are many types of files (also called "file formats"), many variations on individual file formats and many kinds of codecs. The survey respondents identified 26 different moving image file formats with 15 different codecs, and 15 different audio file formats with 6 different codecs. Many of these formats are supported today by commodity operating systems running on popular computer platforms, but some require specialized software and/or hardware. Accessing these files requires at least basic computer literacy, and in some cases more technical skills, especially when it comes to long-term access.

***Basic Preservation Practices: Data Backup, Verification and Migration:***

As previously mentioned, preservation of digital files is an active, ongoing effort. The proper execution of three key activities increases the likelihood that accessibility to digital files will be maintained:

> ***Failure to effectively practice any one of these basic activities will eventually result in data loss.***

- Data backup: Making multiple (two or more) copies of a digital file. The copies should be stored in different geographic locations and on different types of storage media to protect against physical or technical disasters.

- Verification: Regular inspection of all copies of digital files to protect against media or data transfer failure. A related activity is fixity checking, which verifies that a digital file has not been changed, either intentionally or unintentionally.

- Migration: Regular transfer of all digital file copies to currently supported media and file formats to protect against technological obsolescence.

The archivists interviewed for the case studies were asked to identify what they thought were the biggest challenges facing archives that intend to preserve digital audiovisual files for hundreds of years:

> "Paying attention. Can you stay abreast of changes when they happen so rapidly? Will staff forget about it [the files], and wait too long? There's no down time."
>
> "Keeping up with technology. [We] need money to move content forward as technology changes, and appropriate staffing with a strong knowledge base. A preservation/migration plan must be in place.… How much really needs to be digitized? Do we have to do everything, or can we make curatorial decisions?"
>
> "Rapid changing of technology. Equipment, file formats, software. Resources – [we] need people, servers, people who know how to manage the servers."
> "One of the biggest challenges of preservation will be keeping pace with technical changes. I believe that it will be harder for the individual collector to preserve digital materials. As such, there comes a need to ensure that archivists develop strong institutional links that support preservation in order to sustain the mechanism and diligence required to maintain scheduled migration strategies."

The archives that stored files on their parent institution's enterprise storage system had varied levels of influence on preservation and management policies. In survey responses and case studies, the archives that stored files on another department's equipment stated a preference for setting their own archiving policies, but many met resistance when they tried to do so. For example, some archivists favored storing a set of digital backup tapes off-site and migrating the files to a new generation of digital data tape every five years. This conflicted with traditional IT backup practice, which assigns a 30-year life expectancy to the tape stock and does not necessarily recognize the need to re-verify and backup data before the end of the physical media's useful life.

It is important to note that digital data tape manufacturer specifications for a 30-year life expectancy apply to the physical media only. It is currently unknown how long recorded digital data will last with the "store and ignore" approach, but the consensus in the user community is that it will not last anywhere near 30 years.

Furthermore, no surveyed archive would consider storing digital data tapes for that length of time, because today's data storage hardware and software reach technology obsolescence every five to seven years, and digital recording media historically become obsolete after two of these replacement cycles.

Several archives noted the importance of working cooperatively with their institutions' IT departments, if there was one and to forge a relationship in which each department's strengths would be utilized. In an ideal scenario, the archive would recommend digital preservation actions according to archival principles, and the IT department would recommend how to implement those actions. This was considered a practical
challenge, however, as was the determination of cost sharing and operational responsibilities:

***Funding:***
While an archive's digitization budget is often funded by its parent institution, it is defined here as funds allocated to digital preservation activities from the archive's operating budget. This is separate from funding that covers digital projects for the institution as a whole. For example, a parent institution might pay for the creation of an in-house digitization lab, but the lab's staff and their activities are supported by the archive's operating budget.

***Archivists' Recommendations:***
All the surveyed archivists expressed some knowledge of what needed to be done to preserve access to their digital files, and understood the basics of storage, redundancy and migration.

Many expressed concern that resource, organizational and technical issues would hinder their ability to design and implement comprehensive digital preservation programs. When asked what they thought should or could be done to assist them in developing adequate digital preservation programs for their audiovisual materials, the archivists responded with some recommendations and others were proposed by the staff and writers.

***Digital moving image preservation format standards:***

The archival community has not reached a consensus on a standard digital preservation file format and associated codec for moving images. In pursuit of such standards, archives and standards-setting bodies should not simply aim for a single format and its related technical details, but consider a range of formats that address archives' varied technical infrastructures. Recognizing that it might be difficult for archives with limited storage and management capabilities to reformat according to one "highest-performance" standard, the community should take a multi-tiered approach, described in clear language, so each archive could select the formats and codecs that it could best support.

It is worth noting that as of this writing, there are multiple efforts underway that are expected to lead to a set of digital moving image preservation format standards: the Federal Agencies Digitization Guidelines Initiative Audio-Visual Working Group, the Image Interchange Framework project and the Interoperable Master Format project.

***Establish in-house or cooperative digital reformatting facilities:***

Having sufficient equipment and staff for digitizing in standard file formats helps archives with large collections do a larger volume of digital reformatting for preservation and access. Archives that have established in-house transfer capabilities report lower file-handling costs, which allow them to digitize more content than they would if they outsourced to more expensive digitization services. Those archives without the funding or collection size to justify in-house digitization facilities proposed developing cooperative fee-for-service arrangements with archives that are so equipped.

Several of the surveyed archives also suggested building a digitizing "co-op," where several archives would pool their resources to build a shared facility.

***Foster relationships with IT departments:***

Archives at institutions with enterprise storage capability should be encouraged to build relationships with the departments that manage their institution's digital storage systems.

As IT policies and practices for general business operations do not meet an audiovisual archive's needs, open dialogue among all parties rather than an "us versus them" dynamic will lead to more productive dialogue and collaboration. Through this type of collaboration, archivists could learn more about technology and data management, and IT staff could learn about audiovisual archival practices.

***Develop affordable, fee-based digital preservation relationships with neighboring institutions:***
Archives without enterprise storage capability must find other means to safely store their digital files. Given the typical size of archives' budgets and the relatively high cost of commercial data storage services, the surveyed archives suggested forming partnerships with nearby universities and libraries that have appropriate digital storage infrastructures to provide a minimum level of managed data storage at a price they could afford.

***Practice geographic dispersal:***
Archives should store redundant sets of digital files off-site. If they cannot afford off-site storage, they should explore partnerships with other archives in which each participating archive stored copies of another's files. Varying administrative, security and liability policies present significant challenges in this scenario, but however it is achieved, archives should practice geographic dispersal to lower the risk of catastrophic loss.

***Archive-oriented metadata and file management tools:***
Archives recognize that along with managing their digital media files, they also need to create and manage various types of metadata to preserve those files.

They would like to see software tools designed specifically for audiovisual archives rather than production-oriented DAMS or systems built from generic database management software. They also want their digitizing software to produce usable metadata in accepted schema such as PBCore and PREMIS.

***Further education for audiovisual archivists and managers involved in digital preservation:***
Many of the surveyed archivists understood the two basic digital preservation concepts: storage and backup. But most did not have the training or knowledge needed to ensure preservation of their digital objects for the long term. Archivists want a deeper understanding of the principles of digital preservation, especially with regard to audiovisual collections; they believe this will help them in fundraising, working with their institution's managers, creating partnerships and building digital preservation programs. Suggested approaches include workshops that go beyond the panel discussions that are typically incorporated into larger, more general archival conferences, with a focus on digital preservation concepts, digital

preservation standards (to the extent that they exist), “best” practices and the application of ideal goals and principles to the reality of their individual situations.

Nonprofit audiovisual archives that are receiving or generating digital materials have the same problems that were reported for major studios in *The Digital Dilemma*. However, the archives’ problems are compounded by severe resource limitations. This is not to say that the nonprofit community has no significant digital preservation projects in development. For example, the Corporation for Public Broadcasting (CPB) spearheads the American Archive, a comprehensive effort to locate and preserve documentaries and other programs created for public radio and television stations. It is important to note that the CPB has an operating budget in excess of $400 million, which while unusual for an organization in the nonprofit audiovisual archive community, makes the CPB well-suited for such a leadership role.

***A replacement for film as an archival medium:***

An archival system for digital materials that meets or exceeds the performance characteristics of traditional film archives does not yet exist. While many well-funded organizations have implemented fully managed digital storage systems for audiovisual materials, the critical issue of technology obsolescence has not been resolved. This presents a more serious problem for nonprofit audiovisual archives because of their extremely limited resources.

***Standardized nomenclature:***

As of this report’s writing, a unified approach to digital object naming systems had not yet been adopted by the motion picture industry. A few initiatives are underway that may address this problem, such as the International Standard Audiovisual Number (ISAN) and the Entertainment Identifier Registry (EIDR). Standardized nomenclature did not come up as an issue for nonprofit audiovisual archives, most likely because their digital motion picture material management systems have not yet reached a level of sophistication that would make this issue apparent.

***Create film separation masters as archival masters:***

While all of the major studios report that they are creating film separation masters for their theatrically released motion pictures, the process is simply too expensive for independent filmmakers, documentarians and nonprofit audiovisual archives. There have been some reports of lower-cost approaches that use intermediate and print film stocks, but none have achieved significant market acceptance.

AMIA Tech Review
From the Association of Moving Image Archivists
Mav. 2012 | Issue 4

***Enable the enterprise to develop a rational digital preservation strategy:***

The major studios are reportedly reorganizing themselves to manage their digital assets for the long term by improving interdepartmental collaboration and making other structural modifications. Nonprofit audiovisual archives recognize the need to reorganize with digital preservation requirements in mind, but resource constraints, organizational resistance and complexity prevent them from doing so.

***The industry must work together:***

Industry collaboration on digital preservation issues noticeably increased after the publication of *The Digital Dilemma*, and continues as of this writing. This degree of cooperation has been facilitated by the Hollywood community being geographically centralized and sufficiently intertwined from a business perspective. By contrast, the independent filmmaking and nonprofit audiovisual archive universe is far-flung, diverse and loosely coupled. It is consequently difficult to identify exactly which organizations or individuals should be working together – and how they should do so – to generate meaningful results.

***Collaborations:***

The Library of Congress's National Digital Information Infrastructure and Preservation Program (NDIIPP) is an excellent example of how a diverse group of organizations can be brought together and have their energies focused on a common set of problems. The Library recently published a major report on NDIIPP, which details the program's accomplishments and proposes next steps. One of its more significant new initiatives is the National Digital Stewardship Alliance, which seeks to develop a framework for a national digital collection as well as to strengthen and enable public-private partnerships, among other activities. From the motion picture industry's perspective, NDIIPP provided a context for its own collaboration – namely the Academy's Digital Motion Picture Archive Framework Project – which resulted in productive work on file formats, metadata, open source software and data storage research with contributions from the major studios, manufacturers and the research community. However, the diffuse nature of the independent filmmaking and nonprofit audiovisual archive communities makes it more difficult to create a productive, collaborative environment to address their needs.

***Standards Development:***

The nonprofit audiovisual archives surveyed for this report expressed a clear desire for digital moving image preservation standards. It is encouraging to report that as of this writing, there is significant energy within SMPTE and the U.S. Government's Federal Agencies Digitization Guidelines Initiative being directed toward image file formats and related technical details. Metadata standardization has still not been achieved, but pre-standards development work is underway at several organizations, including the Academy.

***Interim Options:***

Archives that have not yet developed an approach to preserving digital materials will eventually face a crisis as their digital holdings grow, whether through acquiring new collections or reformatting their aging analog holdings. At some point, they will be unable to access some percentage of their digital files.

The digital preservation needs of the motion picture industry as a whole have not changed. In this regard the needs of independent filmmakers and nonprofit audiovisual archives seem more urgent, given the changing dynamics of theatrical and non-theatrical digital distribution, the duration of copyright protection, the lack of a defined path to an archive and severe resource limitations.

It also seems unreasonable to burden nonprofit audiovisual archives with a dilemma they did not create, and unrealistic to expect them to organize themselves to tackle the dilemma without help. The studies by the Library of Congress mentioned earlier and the final report from the Blue Ribbon Task Force on Sustainable Digital Preservation and Access all contain calls to action for improved funding mechanisms and collaborative efforts. In effect these studies suggest sharing the burden of devising practical solutions that will enable all community members to maintain access to important cultural, historical and artistic works. Until the underlying operational and technology obsolescence problems are solved, however, a renewed and revised call to action in three key areas seems to be justified:

***Collaboration:***

Identify key stakeholders and representative organizations that can make it their top priority to collaborate on the most pressing unsolved problems facing nonprofit audiovisual archives. As an organized group, they might take on the following initiatives:

***Funding:***

A recurring theme among all surveyed groups was the lack of funding for digital preservation. The final report by the Blue Ribbon Task Force for Sustainable Preservation and Access discusses the funding gap at length and offers concrete suggestions for several archival contexts. Representative organizations in each of the communities covered by this report should review the Task Force's recommendations, and where appropriate, coordinate their efforts so that their constituents will be able to take advantage of applicable strategies and partnerships.

Documentarian and author Betsy McLane suggests that the only way to assure preservation is to have funding organizations insist that applicants include preservation in their budgets. This concept is being implemented in the scientific research community by the National Science Foundation (NSF), which now requires that all grant proposals for NSF projects include a data preservation plan if scientific data is generated as part of the project.

***Education:***
As long as independent filmmakers and archivists stay on the "technology treadmill," they will face the continuous need to refresh and update their knowledge of technologies and practices. The same is true for motion picture producers and executives. Moving image archive programs should offer continuing education classes covering the preservation of digital materials, and archives should require their staff to take them. Industry conferences focused on the content supply chain are good forums for presenting these issues to producers and executives. Likewise, film festivals are excellent venues at which to provide independent filmmakers and distributors with the knowledge to help "keep digital content alive" until the content reaches a suitable archive. Finally, college curricula for aspiring filmmakers and archivists should be updated to cover digital preservation issues so that succeeding generations will be prepared to meet the challenges of long-term preservation of digital materials.

***Cooperatives and resource sharing:***
There is a wide range of operational capability, technical infrastructure and financial resources across the archival community and in related fields, and many examples of successful collaborations in which "the whole is greater than the sum of the parts."

***The Technology Obsolescence Issue:***
There is no escaping the fact that digital technologies enable independent filmmakers to explore and extend the art form in ways that are simply not possible with motion picture film. The price to be paid for these new capabilities, however, is either the loss of content to digital decay, or accepting the responsibility of working with technology providers to articulate and

satisfy industry requirements for the long-term preservation of digital data, backwards compatibility and standards implementation. Collaborations and best practices are insufficient by themselves to resolve the digital dilemma. The underlying technologies must take archival lifetimes into account.

A primary sales pitch by digital storage system vendors is that "storage always gets cheaper," and while that has proven true with respect to storage media, price efficiency is significantly offset by rising energy and labor costs as well as more sophisticated technological support systems and data management policies that such systems require. Increases in data storage density show no signs of abating, but history suggests there is little reason to believe that the already huge (and growing) amount of important digital data will somehow manage itself.

While some claim that following simple data backup procedures can preserve one or even a handful of digital motion pictures, these procedures do not scale for larger collections held at the hundreds of audiovisual archives worldwide. For these archives, the wide variety of incoming data formats and media types, coupled with the archives' limited financial, technological and staff resources, make it impossible for them to do much more than shelve the material while they wait for the largest and best-funded institutions and organizations across the private and public sectors to solve the problem in a way that might yield trickle-down benefits.

Time is and will be the greatest enemy of future access to digital data. Filmmakers ignore the limited lifetime of unmanaged digital data at their own peril. For nonprofit audiovisual archives, continued deferment of a comprehensive digital preservation program will result in mission failure. Interim options offer some possibilities for temporarily extending the accessibility of digital content. The authors hope that there will eventually be a standardized, globally adopted solution that will address the technology obsolescence issue. Until that happens, and without immediate mitigating action, our moving image and recorded sound heritage is in danger of beginning to disappear in a few years. Facing this danger begins with answering key questions during the production of economically or culturally valuable digital work:

- ***Whose responsibility is it to preserve independently created work for future use?***
- ***What would be the economic and cultural impact of losing this work?***

But the broader questions remain:

- ***What will it take to create digital preservation standards and achieve their universal adoption?***
- ***Who will assume the leadership role in solving the digital dilemma for the independent filmmaking and nonprofit audiovisual archive communities?***

***The time for doing studies and defining problems has passed. The issues are clear. The steps to answering these critical questions are also clear, and they start with you, the reader.***

It is the hope of all who worked on *The Digital Dilemma* and *The Digital Dilemma 2* that the next report will be titled *The Digital* ***Solution***.

**Milt Shefter**
**Andy Maltz**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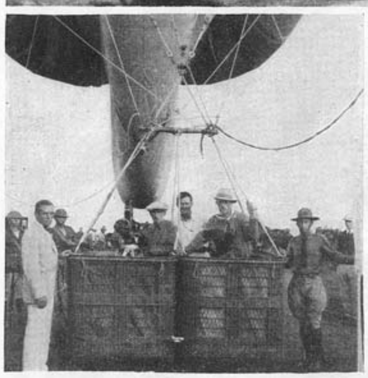
Says John J. Raskob

# $2,000,000 Sham Battle



*The above photograph shows the baskets attached to the blimp from which aerial scenes were photographed. The author of this article may be seen at the right-hand side of the picture holding the flags.*

By
Captain E. P. Ketchum,
*Corps of Engineers, U. S. Army,*
WHO ENGINEERED THIS PROJECT

## *"Wings"—War Movie—Cost $182.00 Per Second to Produce. In One Battle 5,000 Soldiers, 1,100 Mexicans, 50 Airplanes, 20 Tanks and 100 Tons of Dynamite Were Used*

A TOUR of duty at Fort Sam Houston from the military standpoint is always interesting, but when in addition to the normal life of the Second Division one is detailed as sort of a consulting engineer for a moving picture, it becomes particularly interesting and perhaps justifies recording in some fashion.

The author had only recently joined the 2nd Engineers at Fort Sam Houston when he was detailed to Camp Stanley to insure the military correctness of some fortifications that a movie company was to build there. Having just completed a three-year detail at Wilson Dam or Muscle Shoals where the engineering work was of a very high order, the movie engineering to follow proved to be not of such a high order, but certainly as interesting.

A conference with the representatives of the Paramount people was held at Division Headquarters. The theme and sequence of the picture was gone over. Much stress was placed upon photographing the battle scenes from the air. This latter plan meant to me and all concerned that less "faking" could be resorted to because a camera from the air always reveals (as we learn in camouflage) footpaths, etc.

Before proceeding further it should here be inserted that "Wings" originally was to be purely an air picture and it was only at the insistence of the division commander that the ground *battle scenes* were inserted. How well and wisely they were added is attested to by the length or footage allowed these scenes in the completed picture.

*At the right is a photograph of one of the scenes in the screen production "Wings." Fifty airplanes and 20 tanks were used in this stupendous movie "sham battle."*



The picture people having always in mind photographing the battle scenes from the air desired a very extensive battlefield and at first and until a rough estimate of labor and material was furnished them they were speaking in terms of miles! As finally constructed the battlefield was perhaps the largest ever constructed in peace times for any purpose. Full depth trenches were executed for the American front; support and battalion reserve lines with communication trenches, dugouts, etc., for a width of 200 yards with an additional 100 yards on each flank that tapered from the full depth trench up to the virgin soil. The same lines were constructed for the German position. The German front line was in ordinary earth, but the remainder of the position was on a rocky hill! Air compressors and drills were used in the German position!

The author in laying out the trench design with tracing tape, used no standard "trace" (such as the traverse, wavy, zig-zag, etc.), but some of all known traces, with the hope that the completed system would resemble the *actual front* and not a *training camp* layout.

### *Men Divided in Groups*

THE Army had intended my work to be that of a consultant for correct military engineering detail only, but here was quite an engineering problem, and after watching the futile efforts of the picture staff to handle the labor, material, etc., necessary for this construction, I volunteered to organize and direct the work. At the peak of construction there were eleven hundred Mexican laborers employed on the battlefield and most of these were employed on trench construction. These eleven hundred laborers were placed in gangs of about fifty men, each under a foreman. These foremen were nearly all ex or retired soldiers. These gangs were then grouped under general foremen for the following work:

Trench construction; trench accessories (dugouts, revetment, etc.); demolition; wire entanglements.

The general foremen were all army sergeants, and too much credit cannot be given them for their efficient work.

It is one thing to lay out and construct an entrenched position for training and another and more difficult task to lay out and construct one that, when photographed, would resemble the western front. This latter task required the following:

Numerous and varied shell holes; the demolition and burning of trees and foliage; the aging of the trenches; the aging of the wire entanglements; the "dressing" of the battlefield. (*Continued on page 376*)

*At top is one of the "battle scenes" in the picture. The pontoons for the bridges are of real German design, having been brought from the other side for use in the photoplay. Center is another "shot," taken on the battlefield, and at the bottom of the page is a scene in one of the "French villages," built for the filming of the picture.*

# $2,000,000 Sham Battle

By Capt. E. P. Ketchum, U. S. A.

(*Continued from page 299*)

THERE was nothing unusual about the demolition except for the quantity involved. Dynamite was ordered and used by the ton.

The aging of the trenches was accomplished by means of a fire-hose nozzle with a heavy water pressure.

After using water pressure on the trenches, they were partially repaired in sundry fashions known only to those that served on the western front.

The wire entanglements were aged by blowing them up and then partially repairing same.

The "dressing" consisted of placing the proper discarded military material and accoutrements about in seeming confusion.

The construction consumed about six weeks, and all who read this can form an estimate of the cost involved.

The Army had hoped that the battle scenes could be technically correct, but a few trial "runs" proved this to be impossible, since a film showing a correct advance or attack will not greatly interest the soldier, let alone the layman. The picture of 500 men moving up through the communication trenches in direct view of many cameras stationed on towers as high as 100 feet were so disappointing as to necessitate nearly a complete abandonment of pure tactics, and the same was true of the air shots, but justified for the purpose of making a thrilling picture that people would enjoy.

When the battlefield was completed, the entire Second Division moved out to Camp Stanley to participate in the filming of the picture. In advance of the arrival of the division, several model field camps had been prepared so that the incoming troops found their camp sites cleared; streets laid out, piped for water; latrines completed; wired for electricity and the field kitchens ready to receive the field range.

While the division was engaged in making the picture a conference was held daily with most of the following in regular attendance; division and brigade commanders, all regimental and special troop commanders and the picture staff, which usually consisted of the producer (Mr. Lucien Hubbard), the director (Mr. William Wellman) and their various assistants.

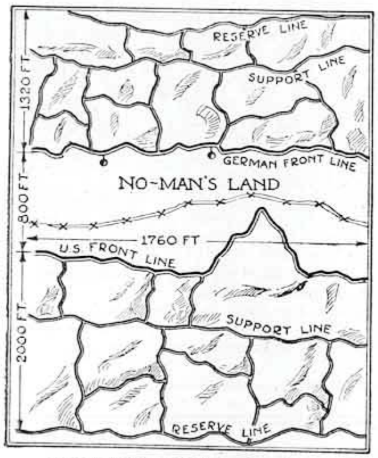
At this conference plans were perfected for the following day's work. These plans called for each unit to be at a certain place on the field at a certain time with certain equipment and very often special dress or uniforms. The action desired was explained to the troops, and some very realistic war marches, attacks, deaths, etc., were executed without picture or special direction.

A great deal of time was devoted to the problem of obtaining an explosion on the field that would resemble the detonation of an artillery shot; that would look to be real and very dangerous and yet one that would be 100% safe for the troops who would be required to advance through these explosions and at times "die" (pictorially) close to or on top of one! Various schemes were tried out, but the one adopted was worked out by the ordnance and the field artillery. This dangerous-looking fake explosion was obtained by digging a hole in the ground about 24" to 36" deep with about the same diameter. On the bottom of this hole was placed a "cushion" of carefully sifted loam and sawdust. On this cushion a pasteboard container containing normally about two sticks of dynamite broken up and mixed with sifted loam and sawdust; then the hole was leveled off by filling with sifted loam and sawdust (see sketch).

These fake explosions were detonated electrically from long, improvised switchboards which were nicknamed "Zip" boards. One can easily imagine the work involved in placing about 1,000 of these shots on the battlefield, wiring them up and having them arranged on switchboards so that any one or group might be fired when required.

The wiring of these shots was done under the direction of the Signal Corps, and the preparation for some of the big scenes required a week of real labor.

The Chemical Warfare Service was used to provide smoke screens to blot out backgrounds that would not harmonize with the western front. Their white phosphorous hand grenades did this very effectively and photographed beautifully.




*General plan of trench system.*

After the division returned to Fort Sam Houston and there remained only a composite battalion to furnish backgrounds for the medium and close-up scenes, the fake explosions, wiring and even the white phosphorous smoke had to be handled by the writer and his small civilian staff.

Some trouble was experienced with this safe fake explosion, due to moisture getting into our dry sifted loam and causing a heavier explosion. On certain occasions the charge had to be reduced to less than one-half stick due to moisture that couldn't be seen or detected.

Every day during the filming of "Wings" was made memorable by one or more happenings of interest, but all of these cannot be recorded here without unduly prolonging this article, but some of the most spectacular episodes only will be touched upon.

### *The First Deliberate Airplane Crash*

LET it first be said that all the flying in "Wings," except for the deliberate crashes by a stunt flyer (Mr. Richard Grace), was done by the regular Army flyers from various flying fields.

Dick Grace was hired to do the dangerous, deliberate crashes, and this narrative now records his two deliberate crashes.

In his first crash Dick was doubling for Buddy Rogers, who is supposed to have a disabled plane and has to make a forced landing on the British front.

When the scene of this crash was thoroughly prepared (the preparation of necessity included an ambulance and fire truck!) and the numerous cameras were in position, Mr. Grace journeyed to Kelly Field—some 20 miles away—to fly his plane over. Just before he left I consulted him about putting mattresses in the bottom of a large shell hole that he might land or be thrown into, but was told not to as they made quite a hot fire! Also just before taking off, the regular flyers in typical fashion of their corps, were claiming Dick's paraphernalia in case the crash was more (or less) successful than planned!

It wasn't long (but to me it seemed ages) before we saw Dick above us circling the field. He was to circle three times, then crash on the spot selected and prepared, and this he did with perfect success and without a scratch to himself. After this scene his plane was found to contain about one quart of gasoline (remember he feared fire—if he knows what fear is). This demonstrated to all that Dick was not only a great and nervy flyer but a very clever and cunning one also.

I am convinced that I suffered more that day than did Dick himself.

### *Dick Breaks His Neck!*

DICK'S second crash was more dangerous but less spectacular to the people who see it on the screen. He was called upon to be shot down from a plane above him as he takes off from the ground and before he has gained any altitude. In this crash he is doubling for a German flyer and is supposedly shot down by Richard Arlen, who has just stolen a German plane to return to the American lines.

Dick carried out the crash as planned, but was unconscious when the scene ended, but upon coming to only complained of a pain in his neck. This second crash took place on a Thursday, and the following Sunday the entire picture staff journeyed to New Braunfels to plan the third crash at a spot on the river which had been previously selected by the producer and the author. The river at the place selected was rather narrow and flanked on one side by a vertical cliff 50 feet high and on the other by dense trees. When selected it was agreed that the "shot" would have to be faked, as it could not possibly be executed by Mr. Grace or anyone else. The plan called for a flyer (supposedly Richard Arlen) to be forced down here; to land all right but to taxi into the river over this 50-foot cliff!

The staff this day included Dick, and although he was complaining of his sore and stiff neck, yet when he was shown the location and the action explained, Dick remarked, "I can do it" or words to that effect. However, Dick didn't execute this last one, as the next day X-rays revealed that he had broken his neck the previous Thursday! And so Dick spent the next few weeks in a hospital inside of a cast.

Although I haven't seen Dick since, I am informed that he is now all right and is still flying.

### *The Bombing of the French Village*

THE art and construction departments built at Camp Stanley out of wood and beaver board a very realistic-looking French village, which was involved in the main plot of "Wings" and which had to be bombed.

It was finally decided to bomb this village from the air, using live bombs, but to insure its complete destruction four large ground charges were placed in the various buildings and one in the church steeple, and the lines were carried back about one-half mile from the village where I could take station with the producer to complete the demolition of the village upon his direction. My charges and lines were in place over a week while we waited on suitable clouds to appear to film the picture.

When a few clouds finally made their appearance one day, it was decided to bomb the village. An ordnance officer was to do the bombing, and as the bomber would have to remain at a very low elevation, so that the cameras could show the bomber and village, at the same time he would have to release the bombs by eye and without using the sights.

The bomber placed all the bombs right through the heart of the village, but each and every one proved to be a "dud," and when Mr. Hubbard (the producer with me) sensed this he asked me to blow it up, but all of my lines were fouled and nothing happened! This proved most fortunate, since a hasty conference ensued at which it was decided to try it again. So the bomber returned to Kelly Field for more bombs, and while he was gone I had our four ground shots checked and rewired, but due to lack of time we could only run them about 100 yards from the village! At this place I had the laborers erect a semi-bomb proof of sand bags. Here again Mr. Hubbard, myself and one assistant took station, but not until I had waved at Captain Stribling in the air to show him our new location and hope he wouldn't drop any "shorts."

Again the bomber placed all of his bombs right through the heart of the village, but this time all detonated and at the proper time all of the ground shots and the church steeple were fired. It was truly a hectic day, but the results on the screen were wonderful and justified our work.

I have tried to confine my rambling thoughts to the ground side of "Wings"—the experiences of the regular flyers on duty with "Wings" is another and very interesting story, but should be told by them.

Due to the help of the Army engineers, the motion picture "Wings" is an exceptionally realistic film. The picture proved to be a huge success and no doubt aided recruiting, especially for the air corps.