

# **Film and Video in the Digital Era**

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## **Introduction**

It was about 20 years ago that the SMPTE “C” format standard was developed. And it was also about 20 years ago that the SMPTE Study Group on High Definition Television was established. The last analog composite NTSC standard was being established just as digital component high definition standardization was beginning. Today that shift from analog composite NTSC to digital component HD is clear. Then it was not.

But, is the transition clear even today? I suggest that many in this room believe it is anything but clear! For example, will broadcasters do HDTV, or multicasting, or data? Will consumers buy HDTV sets, or digital standard definition television sets, or PCs? Will there be analog broadcasting in the year 2007? Will HDTV replace film? Several provocative questions. I am sorry to say I have very few answers. But, I do have lots of opinions. And, as I have the mike at the moment, I’m going to share them with you.

## **The High Definition Center**

Let me begin by telling you a little about my company. The Sony Pictures High Definition Center is a production/post production service facility that specializes in the use of high definition video technology. Originally formed in 1987 as a research and development center by Sony Corporation of America, ownership of the HD Center was transferred to Sony Pictures in 1995. At that time decisions were made that the Center would have to generate sufficient revenue to pay for itself, including R&D, plus return a profit to its parent, Sony Pictures.

The HD Center is in the middle of a film studio. And that is appropriate as we are bridging the film and HD video worlds. We transfer film to HD video. We transfer HD video to film. We transfer film to HD video to film. We produce in HD video, do post production in HD video, and do HD resolution computer graphics. We output in HD video, standard definition or SD video, and film.

## **Film to High Definition Video Transfers**

The HD Center’s largest business area, at the moment, is film to HD video transfer. We have transferred more than 200 feature films to HD. We use real-time, intermittent motion, pin-registered, 1K x 2K, CCD area-array telecines. We bought one machine from Sony a few years ago that was built to our specifications. It can transfer positive and negative 35 mm and 16 mm film. We have another non-real-time, but otherwise the same, telecine for 65 mm film that we built ourselves.

We have contracted with Cinema Products to build two more 35 mm telecines that we will place in service momentarily. These two machines will use the light valve technology the HD

Center developed for primary color correction. This technology will be included in the telecines that Sony will have available next year.

When transferring film, it is mandatory that you maintain proper 24 frame information. If you assume a 60 Hz signal interface, as we have today in the U.S., you must maintain proper 3:2 pulldown. Digital broadcasting, whether HD or standard definition, will use fewer bits for the same quality, or higher quality for the same number of bits, if material originating at 24 Hz is maintained at 24 Hz. That means more programs, or more data, or higher quality. If a TV show is shot with film, for example, then transferred to video for post production, the editing should be on a 24 Hz basis.

Why am I worried about maintaining 24 Hz? It is because we want to use film and digital video in a complementary manner. With the new digital broadcasting standard, you can broadcast 24 Hz material directly. You can encode a DVD with 24 Hz material. When converting our transfers to 625 line video, we drop the fifth, redundant, field to make a 48 Hz tape. When we play back that tape at 50 Hz, there are no 60 Hz artifacts. It is equivalent to transferring the film at 25 frames per second directly to a 50 Hz system. This is possible only if the 24 Hz timing has been maintained.

Why am I concerned about pin-registration? Because it is best to remove any weave before digitizing. If the weave is digitized, it will require extra bits in MPEG compression, whether the compression is for broadcasting, or for DVD, because the weave will appear to be picture motion, and the MPEG encoding will faithfully transmit the weave! Those bits could have been used to give higher quality. The permissible weave in the SMPTE/ANSI specifications for 35 mm films has been calculated to be  $\pm 5$  pixels at 1080x1920 resolution. That's a lot.

I am concerned about quality. That's why I am sold on HDTV. One reason we are transferring films to HD is because the downconverted SD material is superior to a 525 line transfer. Columbia Tristar Home Video titles authored at the Sony Pictures DVD Center are getting top ratings for quality. As a matter of fact, in a *Stereophile* article, out of the top ten A+ titles, six were authored at our facility. Guess what — the video signals used in the authoring came from our HD transferred material.

In our transfers, we make two masters, one is a full frame 4:3 aspect ratio, and the other is a letterbox 16:9. The only purpose of the 4:3 master is for downconversion to 4:3 standard definition. The 16:9 master retains the original theatrical aspect ratio as the artists made it. We do not pan and scan to the 16:9 format. Or, at least not yet. I hope we are not forced to do pan and scan for HD. HBO has said they wish to keep the theatrical aspect ratio in HD. Bravo to them.

## Film Restoration

We have become very involved in film restoration. Our first significant restoration project was *The Matinee Idol*. Frank Capra, the legendary Columbia Pictures director, was born in 1897. This year we are celebrating the 100th anniversary of his birth. The celebration began on January 10th by screening the movie *The Matinee Idol* to an audience of more than 1,000 at the Academy of Motion Picture Arts and Sciences in Los Angeles. So, what is the significance of that? *The Matinee Idol* was a "lost" film for more than sixty years, only recently found, and in terrible shape. It was restored, using digital processing, by the High Definition Center, the first time a live-action feature has been restored in its entirety using digital processing.

In 1928 Frank Capra directed *The Matinee Idol* for Columbia Pictures, a silent black and white movie. Not long after the movie was released, there were no known copies of the film. A couple or so years ago a print was found in the collections of the Cinematheque Francaise under its French title, *Bessie a Broadway*. The diacetate print, once the property of a cine-club in the South of France, received first stage restoration at Immagine Ritrovato, a preservation laboratory in Bologna, and was screened at Bologna's festival of restored films. This screening caused the film to come to the attention of Michael Friend of the Motion Picture Academy and Grover Crisp of Sony Pictures. Knowing that the High Definition Center had been developing techniques for restoring damaged films, they asked the Center to apply those skills to *The Matinee Idol*.

The rediscovered film had many scratches and tears, and numerous frames with large area damage. It had French inter-titles, and scenes had been re-arranged from the original. An interpositive was made from the preservation duplicate negative. The IP was scanned using the HD Center's telecine. Every frame was input to CG workstations for repair. Many repairs were made using automatic software; however, many other repairs had to be made by a digital artist.

After two years of searching, text for the original English inter-titles was found in the archives. The exclamation "A-ha!" appears twice in the film as a graphic, and from this it was possible to identify the original title font of the film. The scenes were placed back in the original order with the re-generated inter-titles. Finally, the HD tape was output to film using the Center's Electron Beam Recorder. This is the film, then, that was screened at the Motion Picture Academy in January to begin the Frank Capra celebration.

Throughout the restoration process, the goal was always to protect the integrity of the original image while removing only those defects that were clearly produced by damage, severe wear, misuse, or deterioration. The goal of the work was always to restore the original achievement of the director; to return the film to a condition as close as possible to the original without changing or "improving" the film. You may have a chance to see this work as part of a Frank Capra retrospective touring in theatres, and it is broadcast from time to time on the cable channel American Movie Classics.

We are now in the process of restoring portions of *Easy Rider*. As some of the original color negative is missing, we have individually transferred YCM separation prints that were made from the original negative and re-combined the RGB signals in an HD edit suite to make a color image. Following CG dirt and scratch removal, we output to film. We have been able to produce a color negative that is superior to the color negative obtained by a photographic re-combination of the YCM prints.

We are developing additional tools to aid our restoration efforts. We need more automatic software to speed up our work, for example, software that can reliably remove tram-line tracks, and flicker.

Let me point out that the techniques we are using to restore film are available only when you digitize the film images. Back in my shop we call that high definition video. Here's a case where HD video can improve film! Much of the point I am trying to make here is that film and HD video are complementary, not adversarial.

## High Definition Production

We have been involved in projects where we shoot and post in HD, and then exhibit as film. With video, you can immediately play back the tape and see how it looks. You can, as well, easily play back the tape the next day as dailies. There is a bit of a problem, though, because the output film will look different from what you see on HD. How do you say to the director that the film will look all right, just trust me. It makes you sound like a used car dealer. We need a way to view the HD through what I will call the “film filter.” The colors the director sees, and the gamma, should look like the final film will look.

There are other pieces of new equipment that we need, not just a new way of monitoring. I must say that the new HD camcorder will be great for our style of production. It can be a completely self-contained battery operated camcorder when we need portability, and it can be controlled from a CCU and the signal recorded with the highest possible quality when we are in an environment where we can operate in this style. In our work, as we often output in film, we must have the highest possible quality. So, we will want to record the highest possible quality under the existing conditions.

Earlier I mentioned the Frank Capra retrospective that is touring theatres throughout the country. Part of the retrospective is a documentary titled *Frank Capra's American Dream*. The interviews were all shot in HD video. All the film was scanned with our HD telecine. The entire piece was then transferred to 35 mm film for exhibition.

## Standards Issue

I have already mentioned one monitoring issue. Let me give you another. In this case, there is a clear need for reconciling different standards. Different SMPTE standards. Or, if it is appropriate to have different standards, at the very least, we need a way to go between them.

What am I talking about? The standard for peak white for standard definition monitors is, I believe, 35 foot lamberts. The standard for high definition monitors is, I believe, 20 foot lamberts. The open gate standard for film projection is, I believe, 16 foot lamberts, which means peak whites are about 10 foot lamberts. Suppose, now, that I am doing some HD work and I want to use it in a theatre environment. Do I monitor color correction at 10 foot lamberts as it will be shown? Or at the HD standard of 25 foot lamberts? What if I also want to downconvert it to NTSC. Do I monitor at 35 foot lamberts? The pictures will all look different! Which should we use as a reference? If the standards must be different, we need guidance on the appropriate “filters” to use when we are monitoring under these different conditions.

As long as I am on the topic of standards, let me mention one more. Colorimetry. Many of you here may not understand what I am talking about, as this is a somewhat esoteric topic, but I just have to get this off my chest. SMPTE led the world on colorimetry in developing SMPTE 240M. It was the first standard that fully specified the relationship between light and voltage. This work, slightly modified, was absorbed into the International Telecommunication Union's colorimetry specification in ITU-R BT.709. I believe the SMPTE standards for 1080x1920 and 720x1280 systems use the ITU defined colorimetry. The ATSC Standard incorporates the ITU colorimetry as the preferred colorimetry for all digital television, not just digital high definition television. I hope we can keep it that way. I continue to hear rumblings that, perhaps, we should

continue to use the old NTSC matrix equations. This is our opportunity to completely and properly specify colorimetry. Please, we're so close, let's not lose it now.

### **Electronic Production at 24 Frames Per Second**

At the ITS Forum in July, Sony announced they would be developing a 24 frame per second, 1080x1920 high definition production and post production system. At the HD Center, we are excited by this. In fact, we were among those pushing Sony to develop such a system. As we work with both film and HD, it will be very helpful to us to have 24 frame video. It will make it easier for us to cut video and film into the same project.

As an example, consider *Frank Capra's American Dream* that I mentioned earlier. As I said, the interviews were shot in HD video — at 60 Hz, and the film was scanned at 24 Hz. Then the entire piece was transferred to film at 24 Hz. This is an excellent example of the case where 24 Hz HD video would be helpful. Obviously, the interviews would have been shot at 24 Hz.

We believe there will be a demand for this equipment for some television productions, especially, prime-time programs.

It will be especially useful for clients who wish to shoot and post in HD video, and then release in film.

### **DTV Broadcasting**

As I am the author of the infamous Table 3, I must speak about digital broadcasting. Through the many long years we spend developing the U.S. standard, we constantly had in mind high quality, and flexibility. High definition was always the target. Even when we included standard definition in the standard — that's flexibility. Even when we moved 100% to digital — that's flexibility. Even when we took steps to ensure computer interoperability — that's flexibility. Even when we allowed data broadcasting as part of the standard — that's flexibility.

With regard to the "18 formats" in Table 3, we sought to facilitate flexibility. How could we disregard 60 Hz and 30 Hz, the way television has been done in the U.S. for decades. How could we disregard 24 Hz, the way film has been done for a long time, since the beginning of time as far as I know. How could we disregard ITU-R BT.601? How could we disregard the VGA standard? We couldn't. It was obvious that it was necessary for receivers to have flexibility rather than require every broadcaster to convert material to a single format.

Most of the concerns we have heard over the past year actually stem from the flexibility that is built into the standard. Choices can be made. I guess that can be frightening!

I am looking forward to the digital broadcasting era. It should begin in less than one year. Actually, digital stations, experimental digital stations, have already been on the air for more than one year. There may be two dozen or so in a year. And receivers should be available. Wide screen high definition receivers. I can hardly wait!

### **Consumers Will Embrace High Definition Television**

We have had the 525 line television system for more than 55 years. We added color almost 45 years ago, and stereophonic sound about ten years ago. The system has improved very much over the years. But, it is not high definition.

PCs began with alphanumeric displays of 80 by 25 characters. Shortly thereafter, CGA “sort of” matched NTSC quality. Quickly the quality level stepped up to EGA. Then VGA. VGA is “sort of” a progressive scan NTSC with improved horizontal resolution and no composite video artifacts.

The lowest quality format in the ATSC Standard, the 480 line interlaced format, exceeds NTSC quality because it has VGA horizontal resolution and is a component signal. I would describe the ATSC Standard as having four quality levels. The next step up, 480 progressive scan, is VGA quality. PCs long ago, however, went beyond VGA quality. I suppose most PCs sold today are used with SVGA quality. Many are XGA quality. This is about the quality of the third step in the ATSC Standard, 720 lines progressive. The top level in the ATSC Standard is 1080 lines. At 24 frames per second, for film, which is most of prime time television, it is progressive scan. This is “sort of” the 1200x1600 level of PCs as the number of pixels in the frame are within 7% of each other.

With a PC, you can have different screen resolutions depending on what your monitor is capable of doing. Most applications, but not all, will work in different resolution modes. This is what is possible with the ATSC Standard. If HD is being broadcast, and the receiver is an all-format receiver, the image seen at home will be the resolution of the display device.

Just as consumers have demanded higher quality images in PC monitors, I believe they will demand higher quality images for television. The ATSC Standard was crafted to provide this quality, just as it was crafted to bridge the gap between computers and television. In the HD Center’s screening room, I can vividly show you the quality that is possible. I have a theatrical release print of the Columbia feature *Fly Away Home*. This is one of the films we have transferred to HD. The Model HDTV Station in Washington, DC, WHD-TV, broadcast the film for me, at 24 frames per second progressive scan, recorded the received decompressed image, and sent me the tape. I can project the 35 mm print, and I can project the received HD signal. On the same screen. At the same size — 16 feet wide. I can emphatically state that the ATSC Standard will allow consumers to experience the 35 mm theatrical experience at home. If you don’t believe me, come see for yourself. You are all invited to my screening room in Culver City. Just call me first! I will be most happy to welcome you.

### **Film and HD Video Will Coexist and Complement One Another**

During the television season last year, two-thirds of the Columbia Tristar Television prime-time programs were shot with 35 mm film. Standard definition video was used for about 25%. About 10% were shot with 16 mm film. I believe these numbers are similar throughout the industry.

Over the past few months, there have been discussions on what should be used to shoot programs that will be broadcast in digital HD. I suspect that everyone here will say that the program content is what matters, not how it is shot. And, I would agree.

But, let me go a step further. Suppose that two shows are broadcast at the same time, and that they are equally desirable in terms of content. Which will people watch if one is HD and the other is standard definition? Will that make a difference? What if consumers have embraced HD? Does that make a difference? I can remember in the 60’s when there was a mix of color and black and white programs. People who had color sets did tend to watch more of the shows that were

broadcast in color. Did shows shot in color have better content? Do shows shot in a higher quality format have better content?

Is it really necessary to use 35 mm film for standard definition broadcasting? If it is not necessary, then why is it used for two-thirds of the programs now? Why would you expect producers to move from 35 mm to 16 mm, with a four to one DECREASE in film area per frame, when you move from broadcasting in standard definition to high definition which has an eight to one INCREASE in pixels per frame? It sounds strange when I put it that way, doesn't it!

Perhaps this really is not an issue. Don't you think that producers will continue producing their shows in a manner that is most comfortable to them. Don't you think that any changes in quality will be toward higher quality, not lower quality.

Again I will make the same point I have made several times already. We want to find the things that can be done best with HD video and the things that can be done best with film. If cost issues push you one way, so be it. If technical issues push you another way, so be it. If artistic issues push you still another way, so be it. We want to exploit both technologies, separately and together.

## **Wrap Up**

At the beginning of my comments, I asked if the transition from analog composite NTSC to digital component high definition was clear today. Have I helped clear up anything? I doubt it. Most of us have reached our own conclusions, and only the reality of the future will clarify things. I asked some other questions, about HD, and multicasting, among other things.

But first, let me digress for a moment. There is a television show I have been watching for years. It is *The McLaughlin Group*. John McLaughlin and his four regular guests discuss issues, normally political, of the previous week. John will typically ask a question of his guests. After they give a response, John will give "the answer." So, now I am going to give you "the answers" to my questions!

Broadcasters will broadcast HD, and multicast SD, and transmit data. Consumers will buy HD sets, and digital SD sets, and PCs. There will be analog broadcasting in the year 2007; but I am not sure about the year 2008! And HD and film will live happily ever after.