Understanding HD

Your comprehensive guide to
High Definition on a budget

Avid

Part Three

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Chapter 6

Digital Film

Avid

In years gone by, many TV dramas, documentaries and 'soaps' were produced on film. Today, not only is that is becoming increasingly rare as HD and digital technology shows many benefits in these areas, but the movies themselves are going digital. Shoots and cinemas may still use film but all the processes between increasingly are digital. A number of movies have been shot on digital cameras, including blockbusters such as Sin City and the later Star Wars episodes, and the installation of digital cinemas is gathering pace. Digital film has many crossovers with television as well as its own standards and terminology.

10-bit log

Widely used for digitising film material, this usually refers to 10-bit sampling of an image, that describes 210 or 1024 discrete numbers or brightness levels which have logarithmic scaling – rather than the linear scale that is always used in television. This highlights a major difference in the way that film and television material is shot. In film, the camera negative is designed to pick up as much detail as possible over a very wide brightness range of up to 11 stops – equivalent to a contrast ratio of over 2000:1 and capturing all detail from bright sunlit objects to down in the shadows. This gives latitude for later adjustments and grading before selecting the much more limited contrast range used for the release print that gives a punchy presentation at the cinema.

In television it is always possible to see exactly what the images look like and so any adjustments and selections are be made live while the camera is shooting. What you record is, essentially, what viewers see and this may be 8 stops – a contrast range of 256:1 – but it looks great at home.

So a television image and a film negative carry very different information. While 10 bits (linear) is usually plenty to smoothly resolve all the contrast levels in TV, a film negative needs about 13 bits (linear). However as we can detect small brightness differences in darker areas and only larger ones in bright areas, assigning more digital levels to low light, and fewer to the highlights is a more efficient way to use the available digital levels. This is what the 'log' sampling does.

See also: Quantizing (Video formats, colour space and sampling)

2K

This is a picture format generally used with images scanned from 35mm motion picture film, as well as a slightly different format for cinema exhibition. For the production side, it refers to 1536 lines each with 2048 pixels and describes a 4 x 3 aspect ratio picture. The sampling is 4:4:4 RGB with 10-bit log accuracy to carry the full sharpness and contrast detail of 35mm negatives. This is not a television format but 35mm film is commonly scanned to this resolution for use as 'digital film' for effects work and, increasingly, to input to DI for grading, cutting and mastering.

For publishing in television, a 16:9 (1080 x 1920), and a 4 x 3 aspect ratio window can be selected from the 2K material for HD and SD distribution. The format is also suitable to support high quality transfers back to film or for direct D-cinema exhibition. Just as with film, not all the original image is shown on the screen. For digital projection 2K refers to a size or 2048 x 1080 lines, giving a wide aspect ratio display.

4K

This is a digital film production image format of 3072 lines by 4096 pixels – four times the area of 2K. With each image producing about 32MB of data it requires a powerful workstation to play and process 4K footage in real time. Also the storage requirement is massive. Despite the current technical challenges, a small but increasing number prefer to work at 4K partly as it is seen as more future proof than 2K. Also some effects shots that have to be seamlessly re-inserted back into a 2K movie may be created at 4K. As the onward march of technology makes 4K easier and less costly to use, so it will become more widely used as a digital film mastering format alongside 2K.

CineAlta

Sony's name for its family of products that bridge cinematography and HDTV and includes HDCAM-based camcorders and studio VTRs as well as extending to whole production and post production systems. The more recent HDCAM SR series offers a more refined cine package with higher recording data rates and direct access to the original RGB images, rather than the 'gamma corrected' images used for television.

See also: 24PsF

Dark chip

See DLP Cinema

D-cinema and E-cinema

D-cinema or Digital Cinema may involve the whole scene-to-screen production chain but it is usually refers to the distribution and exhibition of cinema material, movies, by digital means. There are no hard-and-fast rules about what constitutes D or E-cinema but some say D-cinema, images should be 2K size or bigger. Smaller HD or SD formats then fall into the E-cinema category. Nonetheless audiences have been generally impressed with the results from HD projections.

Digital presentations lack film weave, scratches, sparkles etc., to deliver a new standard of technical excellence to the cinema screen and, unlike film, quality is maintained regardless of the number of replays. Digital movies are distributed by disks or over networks rather than on 35mm film that costs around $1000-2000 per copy which lasts only about 200 passes through the projector. Copying and distribution of film prints cost an estimated $800 million per year, spent by studios.

E-cinema is currently further developed than D-cinema and already has proven viable in a support role to the main features. It allows low cost production of local advertising and promotions as well as the flexibility to easily add any other TV-based content.

Among the necessary technologies, the recent rapid development of high-resolution, large screen digital projectors has made digital cinema exhibition possible. These are based on three technologies: D-ILA, DLP and SXRD.

D-cinema standards have recently been recommended by Digital Cinema Initiatives.

See also: DCI, DLP, D-ILA, SXRD

DCI

Digital Cinema Initiatives was set up in 2002 by a group of major Hollywood studios to establish an open digital cinema set of standards that ensures a uniform high level of technical performance, reliability and quality control. The standard was completed in 2005 and is being implemented by various suppliers. Among a host of detail including security, its recommendations include 2K and 4K image formats and JPEG 2000 compression.

WWW www.dcimovies.com

Digital Cinematography

Digital Cinematography refers to the use of electronic cameras in shooting material for movies. A number of cameras have been designed specifically for this as alternatives to 35mm, including Viper (Thomson), CineAlta range (Sony) and DVCPRO HD (Panasonic). These produce HD formats, can run at 24P, capture a wider contrast range than TV cameras and do not use TV's gamma correction curves. Origin (Dalsa) and D20 (ARRI) provide larger D-cinema sized images: Origin offers up to 4K and D20 3018 x 2200 active pixels. The D20 also offers frame rates from 1-60 fps. These cameras are designed as an alternative to 35mm movie cameras however any video camera could be used.

Digital Intermediate (DI)

Digital Intermediate is a digital alternative to the traditional photochemical process that accepts original camera negative (OCN) and produces the internegatives that make the release prints of a movie. This has always included many stages of colour grading to match up all the shots seen in the final release print. DI is increasingly accepted as the preferable and path as, depending on the system used, it can be instant, interactive, presented on a big screen, can have audio and allows any grading changes right up to the outputting the internegative film from the graded and edited digital internegative. This way the grades are made on the edited material, complete with all effects shots, rather than looking at isolated individual shots. It is also possible to output fully graded whole reels, rather than applying further final when making the release prints.

DI starts with scanning the 35mm film. This is usually made at 2K size using 10-bit log RGB (4:4:4) sampling to carry all the sharpness and contrast detail from highlights to deep shadows, from the film into the digits. The contrast latitude is needed to allow headroom for onward grading. If using footage from a digital cinematography camera, the scanning operation, which can be quite costly, is not needed.

D-ILA

Direct-Drive Image Light Amplifier. A technology that uses a liquid crystal reflective CMOS chip for light modulation in a digital projector. In a drive for higher resolutions, the latest developments by JVC have produced a 2K (2,048 x 1,536) array, which is said to meet the SMPTE DC 28.8 recommendation for 2000 lines of resolution for digital cinema.

The 1.3-inch diagonal, 3.1 million-pixel chip is addressed digitally by the source signal. The tiny 13.5-micron pitch between pixels is intended to help eliminate stripe noise to produce bright, clear, high-contrast images. This is an efficient reflective structure, bouncing more than 93 percent (aperture) of the used light off the pixels.

See also D-cinema

WWW www.jvc.com/prof

DLP

Digital Light Processing: Texas Instruments Inc digital projection technology that involves the application of digital micromirror devices (DMD) for television, including HD, as well as cinema (see DLP cinema below). DMD chips have an array of minute mirrors which can be angled by +/- 10 degrees so as to reflect projection lamp light through the projection lens, or not. Since mirror response time is fast (~10 microseconds), rapidly varying the time of through-the-lens reflection allows greyscales to be perceived. For video, each video field is subdivided into time intervals, or bit times. So, for 8-bit video, 256 grey levels are produced and, with suitable pre-processing, digital images are directly projected.

The array, which is created by micomachining technology, is built up over conventional CMOS SRAM address circuitry. Array sizes for video started with 768 x 576 pixels – 442,368 mirrors, for SD. The later 1280 x 1024 DMD has been widely seen in HD and D-cinema presentations. Most agree it is at least as good as projected film. TI expect to offer an 'over 2000-pixel wide' chip in the near future.

While much interest focuses on the DMD chips themselves, some processing is required to drive the chips. One aspect is 'degamma': the removal of gamma correction from the signal to suit the linear nature of the DMD-based display. Typically this involves a LUT (Look Up Table) to convert one given range of signal values to another.

See also: Gamma

WWW www.dlp.com

DLP cinema

This refers to the application of Texas Instruments' DLP technology to the specific area of film exhibition. Here particular care is taken to achieve high contrast ratios and deliver high brightness to large screens. The development of 'Dark chips' has played an important part by very much reducing spurious reflected light from the digital micromirror devices. This has been achieved by making the chip's substrate, and everything except the mirror faces, non-reflective. In addition, the use of normal projection lamp power produces up to 12 ft/l light level on a 60-foot screen.

See also: D-cinema, DLP

HD RGB

Television usually uses 4:2:2 component video (Y,Cr,Cb). Slightly higher quality can be achieved through using RGB sampled at 4:4:4. Many of the digital cinematography cameras offer this type of output that can use linear or log sample scaling. The 1080 x 1920 HDTV image format is very close to the 2K projected image size, so RGB HD can be considered as a TV/film crossover format, able to take advantage of many of the economies and speed of TV equipment to produce 'film' quality results.

ILA

See D-ILA

OCN

Original Camera Negative has very high value and is designed to hold a very wide contrast range. It is always handled with great care and, to avoid damage, as little as possible. The onward path toward making a programme involves either scanning the OCN and proceeding along the DI route, or copying to make an interpositive film, and so on into the photochemical intermediate chain.

SXRD

Silicon X-tal Reflective Display (X-tal is short for crystal) is digital projector display technology developed by Sony. Its first claim to fame was that it provided the first viable 4K (4096 x 2160 pixels) size as incorporated in Sony SXRD projectors. The design of this reflective liquid crystal microdisplay is also aimed to provide for enhanced contrast, speed allowing up to 200 fps and minimises image smear, and offering extended service life.


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Post production and editing
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Shot selection and editing for film and video are now undertaken using nonlinear editing systems. Post production has grown immensely in importance with the advent of highly-capable online digital equipment and nonlinear editing. Now it is often cheaper to 'fix it in post' rather than spend extra time on another take on the set.

AAF

Advanced Authoring Format. This is an industry-driven, open standard for the multimedia authoring and post production industries which is supported by many companies, including Avid. It is intended to enable content creators to easily exchange complete digital media – video, audio and metadata – across platforms and between applications. It simplifies project management, saves time and preserves valuable metadata that was often lost in the past during media transfers.

It is in editing and post production areas that the metadata load is greatest and individual systems and applications have become isolated by incompatibilities,: so limiting their interaction, interoperability and usefulness. Use of the AAF file format allows the passage of full information between AAF-enabled applications. Thus video, audio and metadata, with the decisions about how material has been manipulated (cuts, DVE, colour correction etc.) and assembled – a complete, modern-day EDL – can always be available and, where needed accessed. The metadata also passes on existing, original information such as timecode or edgecode, ownership, previous editing etc. that helps with any later archive retrieval and versioning.

See also: EDL, MXF, OMFI

WWW http://www.panasonic.com

Blue screen

Shooting items against a blue background or screen allows them to be cut out and keyed onto other backgrounds. The blue is normally chosen as being unique in the picture and not present in the foreground item to be keyed. This should enable easy and accurate derivation into a key signal used to cut out the object. Consideration may also be given to the colour spill onto the object's edges. So, for example, if the object is set into a forest, maybe a green screen would be preferred. Modern colour correction and key processing allow a wider choice of colour and the possibility of correcting for less-than-perfect shoots. However, this will increase post production time and effort.

The accuracy of the key signal derived from blue screen shots depends on the accuracy and resolution of colour information. Unlike SD, where the popular Digital Betacam or DVCPRO 50 records 4:2:2 sampled video using only 2:1 or 3:1 compression, most HD recorders do not offer equivalent quality with the 100-140Mb/s camcorders, where restrictions in chrominance bandwidth can limit the effectiveness of HD key. The notable exception is HDCAM SR, offering up to 440Mb/s with 10-bit 4:2:2 (4:4:4 possible too) sampling with 'lossless' compression.

Content

Any material completed and ready for delivery to viewers. Content is the product of applying metadata to essence (for TV, video and audio).

See also: Metadata

Chroma Keying

The process of deriving and using a key signal formed from areas of a particular colour in a picture (often blue, sometimes green).

See also: Keying

Colour correction

Historically this is the process of adjusting the colours in a picture so that they match those from other shots or create a particular look.

Colour correction in HD and SD television has become highly sophisticated. This can include secondary colour correction that can be targeted at specific areas of pictures or ranges of colour. So, for example, a blue car in a commercial can be changed to red. Depending on equipment, operation can be real-time and interactive; enabling fine adjustments to achieve precise results in a short time.

Compositing (a.k.a. Vertical Editing)

The process of adding layers of moving (or still) video to assemble a scene. This involves many tools such as DVE (sizing and positioning), colour correction and keying. As the operation frequently entails adding many layers, the work is best suited to nonlinear equipment using uncompressed video to avoid generation losses. Techniques are now highly developed and are a key part of modern production for both film and television – cutting production costs and bringing new possibilities and new effects.

CSO

Colour Separation Overlay. Another name for chroma keying.

See also: Keying

DS Nitris

DS Nitris is Avid Technology's flagship effects and editing solution for HD and film resolutions. It was launched in September 2000 and based on the successful V4 release of DS (Digital Studio) code. The original version had no hardware acceleration and was entirely software based with the exception of input/output operations, but the Nitris DNA hardware offers powerful hardware acceleration, while still benefiting from the continuing development of faster CPUs.

The system is well supported by nearly all plug-in manufacturers and is resolution-independent. It also supports the transparent import of multi-layered effect-based OMF files from products such as Avid Media Composer and Digidesign's ProTools to provide an efficient link between off-line and on-line operations.

DTF/DTF2

Name for Sony's half-inch Digital Tape Format which offers high data storage capacity (up to 200GB) on half-inch tape cartridges. Such stores are often used for storing digital video – such as HD – in post production areas, where they may be available to clients on a network.

EDL

Edit Decision List. This is data that describes how material is to be edited, e.g. from offline to online, or a record of what happened in the editing process.

EDLs were devised before the days of nonlinear editing and were never updated to take on board any of the digital enhancements such as DVEs and advanced colour correction and keying. Even so, they remain in wide use as a well-recognised means of conveying the more basic editing decisions, cuts, dissolves, wipes, slo-mo, etc. Popular formats are CMX 3400 and 3600.

More recently, new initiatives such as AAF and OMF offer the far wider capabilities needed for today's production needs. OMF has become a de facto standard for transferring full decision data between offline and online operations.

See also: AAF, OMF

Essence

Term used to describe essential material which, for television, is what appears on the screen and comes out of the speakers – video, audio and text. Essence consists of those recorded elements that may be incorporated by means of editing, mixing or effects compositing into a finished programme (content).

See also: Content, Metadata

Gamma (correction)

Gamma describes the difference in the brightness transfer curve characteristics between video source devices, such as the CCDs in cameras, and the response of the display devices – usually considered to be cathode ray tubes. Gamma correction is normally applied early to the source video R, G, B signals as part of the processing in cameras. It is imposed here as it makes the video signal more impervious to atmospheric noise during 'over-the-air' analogue transmissions. However, the more recent use of other display devices – plasmas, LCDs and DLPs – with very different technologies and gammas means that they must again adjust gamma to match their transfer characteristics. For example, DLP technology uses Digital Micromirror Devices (DMDs) – millions of mirrors that are actually time-modulated. The amount of light they reflect onto the screen is a function of a duty cycle for time 'on'. Thus, DLP systems program the display gamma for any given luminance level by adjusting the exposure time for that level through a Look Up Table (LUT).

Gamma corrected colours or components are annotated with a prime, e.g., R′, G′, B′, and Y′, Cr′, Cb′. As virtually all mentions in this document involve gamma corrected signals, the primes have not been included, for simplicity.

See also: DLP

Grading

Colour grading, also called colour correction, involves adjusting the colour of recorded footage. This is highly skilled work and depends on sensitive and very accurate adjustments. Traditionally, television has not had a use for grading as all cameras are matched to make a TV programme, but when shooting over several days, with isolated (iso) cameras, or simply using footage from a number of sources, grading becomes necessary so that all shots have the same colour look.

Primary grading is applied to whole frames. Secondary grading involves adjusting the colour of a specific area of a picture. This could be to grade an object or to affect a specified range of colours – perhaps to change seasons by modifying the green leaves of spring to look like the hues tones of autumn. Defining the area to be changed may well involve using a key (see below)

Keying

A general term for the process of placing an object or section of picture over another – as in keying text over video. This is a video version of matting in film but may use interactive tools and feature live operation.

Operation splits into two areas, deriving the key signal and applying it to produce the keyed result. In HD's high quality, big picture environment it is essential that keyed results are accurate and look convincing. Increasing use of compositing to add scenery, objects and actors to make footage that the camera never saw, requires excellence in keying so that the keyed items look 'photo-real' – like a part of the original image.

Keying tools have developed rapidly with the introduction of digital technology and online nonlinear editing. If working with electronically generated material, such as graphics or captions, the key signal is supplied along with the video. Otherwise sophisticated means are available to derive the key signal. Typically, objects are shot against a blue or green screen and that colour then defines the key signal. In reality the key colour spills onto the object so de-spill techniques are applied. The boundary between the object and background is often the subject of much effort. It is rarely a hard cut (hard key), which tends to look jagged and false, but a carefully set up dissolve to render a smooth, natural-looking edge (shaped or linear key).

Further techniques are used to key semi-transparent material such as smoke, fog, and glass. Often this uses a non-additive mix technique which apportions foreground and background according to its luminance.

The availability of highly developed digital keying techniques has been a large factor in swinging motion picture effects into the digital domain. Their excellence and efficiency has changed the way many are made, cutting costs by simplifying the shoot and avoiding some expensive location work.

In digital systems, the key is a full-bandwidth signal (like Y, luminance), and is often associated with its foreground video when stored. Disk-based nonlinear systems can store and replay this video-with-key combination in one operation, but it would take two VTRs.

See also: Blue Screen, 4:2:2:4, 4:4:4:4

Media Composer

This series of non-linear editing systems has formed the core part of Avid's business over recent years. There are many permutations of hardware platforms, video cards and breakout boxes on both Apple Mac and PC formats. Seen as the de facto standard in editing for both on-line and off-line, Media Composer has tens of thousands of users worldwide and touches the vast majority of mainstream film and television production.

See also: AVR

Metadata

Metadata is data about data. Essence, or video and audio, is of little use without rights and editing details. This information also adds long-term value to archives.

Metadata is any information about the essence, for instance how, when (timecode) and where it was shot, who owns the rights, what processes it has been, or should be, subjected to in post production and editing, and where it should be sent next. Uses with audio alone include AES/EBU with metadata to describe sample rate, also metadata in AC3 helps the management of low frequencies and creating stereo down-mixes.

Typically the audio and video essence is preserved as it passes along a production chain, but the metadata is often lost. Avid with OMF and the AAF Association have both done much to rectify this for the area of editing and post production.

See also: AAF, Essence, OMF

MXF

Material eXchange Format is standardised in SMPTE 377M and supported by the Pro-MPEG Forum. It is aimed at the exchange of programme material between file servers, tape streamers and digital archives. It usually contains one complete sequence but this may comprise a sequence of clips and programme segments.

MXF is derived from the AAF data model, integrates closely with its files and so bridges the worlds of file-based and streaming transfers. It helps to move material between AAF file-based post production and streaming programme reply over standard networks. This set-up extends the reliable essence and metadata pathways so that both formats together reach from content creation to playout.

The MXF body carries content, which can include MPEG, DV and uncompressed video, and contains an interleaved sequence of picture frames, each with audio and data essence, plus frame-based metadata.

WWW www.pro-mpeg.org

Non-additive mix

See Keying

OMFI

Open Media Framework (OMF) or Open Media Framework Interchange (OMFI) is a platform-independent file format intended for transfer of digital media between different software applications and equipment. Besides sending the video and audio, the transfers can include metadata about the content and what editing and other processes it has been through. It is used by Avid products, Final Cut Pro, Pro Tools and others. It is the basis for the AAF.

Photo real

Term to describe effects-generated material that looks as if it originated from a camera. This may apply to computer-generated objects or to items shot on camera and composed into the picture. Here, attention to detail such as shadows and reflections as well as keying are needed to maintain the illusion. Achieving such quality at HD and film resolutions is all the more demanding as their bigger, sharper displays make detail, including errors, easier to see.

See also: Keying

Plug-ins

A generic term for software applications that can be added to existing applications to enhance their functionality. Nonlinear video and audio systems are often expanded with new effects or functionality via plug-ins.

Symphony

Avid's Symphony is a pure editing and finishing tool with real-time effects processing which offers advanced primary and secondary colour correction, captioning and titles. Initially working only at SD, its universal mastering allows users to generate both 525/50 and 625/50 version of an edit in real-time from a 24P master.

Symphony's real-time uncompressed performance is extended to HD with Avid Nitris DNA hardware. Symphony Nitris systems combine Symphony's full finishing toolset to provide real-time uncompressed HD and SD performance using Avid Nitris DNA hardware.

Timecode

Timecode is a 24-hour frame-accurate reference of hours, minutes, seconds and frames and fields designed for television production use. For example 10:32:24:16

Typically it is recorded with the video and is the first reference when logging and editing. EDLs run on timecode. It is relatively straightforward in the 25/50Hz frame-rate world but gets a lot more complicated in the 30/60Hz world where, for historic reasons, the whole number frame frequencies was offset by a factor of 1000/1001 – hence 29.97 and 59.94Hz. To make up the time to that of a whole 30 or 60Hz rate, one frame is dropped in every 1000. This 'drop-frame' is accounted for in drop-frame timecode.