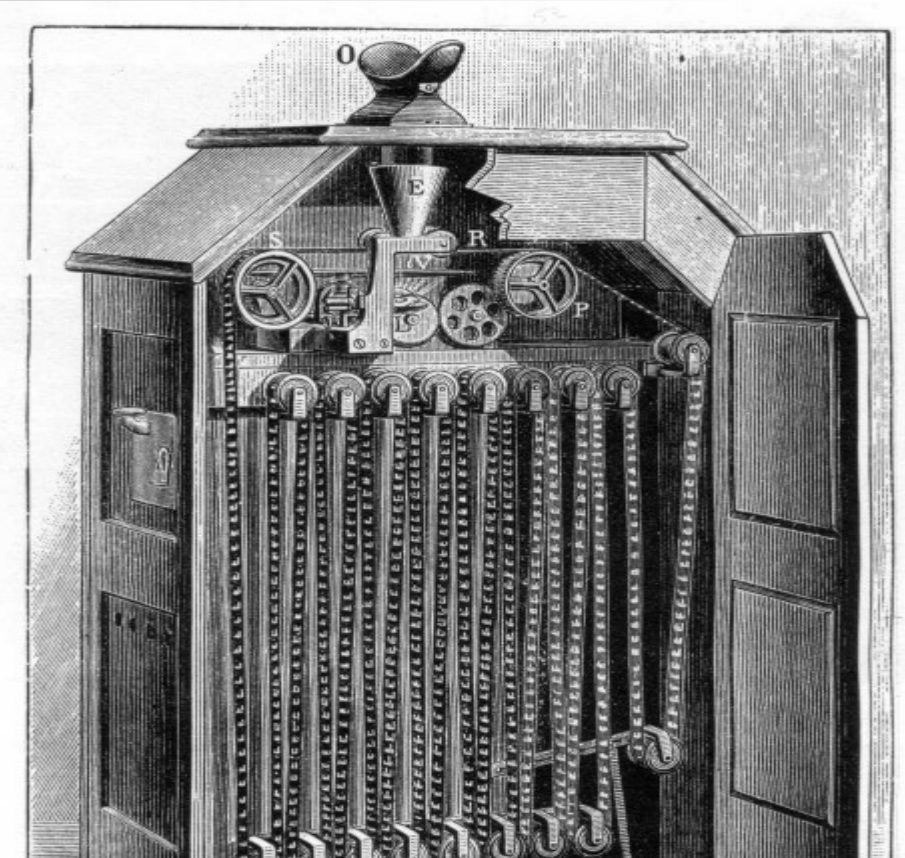
Now Playing
At a theater near you

New technology in cinema

Cinema Technology

A brief history

1888 - Kinetoscope

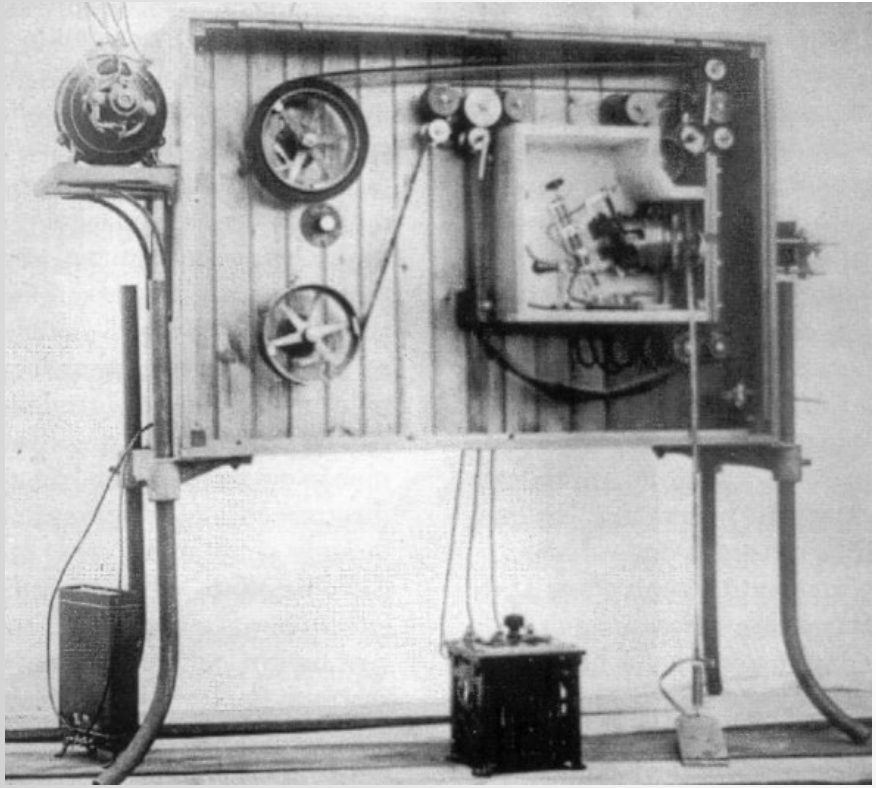


One inch wide film (25.4mm) at 48 frames per second. Viewed with Kinetoscope (“peep hole” - not projected). Edison/Dickson

1894 - Cinématographe

35mm film, 18fps, combination camera and projector. Lumiére brothers. December 1895, customers paid 1 franc for a 25 minute show.

1896 - 70mm film



American Mutoscope and Biograph Company produces cameras, projectors, and films with 70mm width for better image and to avoid Edison patents.

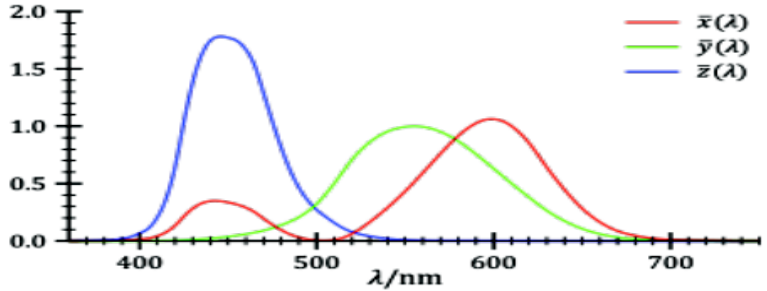
1906 - Color Movies Invented

Kinemacolor ran at double frame rate (32 fps) with one frame shot and projected through a red filter, the next frame shot and projected through a green filter. Used commercially until 1914. “Frame sequential” was the first FCC approved color TV system in the US. You had a big color wheel in front of your TV.

Color Perception

XYZ and the Eye

We can model the color perception of the eye as three band-pass filters. The ratio of the amplitudes out of these filters is how we determine the color of light. If we look at a monochromatic red light source, which has a wavelength of about 650nm, the X filter has the most output, the Y filter less, and the Z filter almost nothing. Looking at monochromatic green (510nm), the Y filter has the most output, followed by Z and X. Yellow monochromatic light (570nm) results in about equal output of the X and Y filters, and almost no output from the Z filter. As the color varies between red and green, we can use the ratio of the X and Y filter outputs to determine the color.

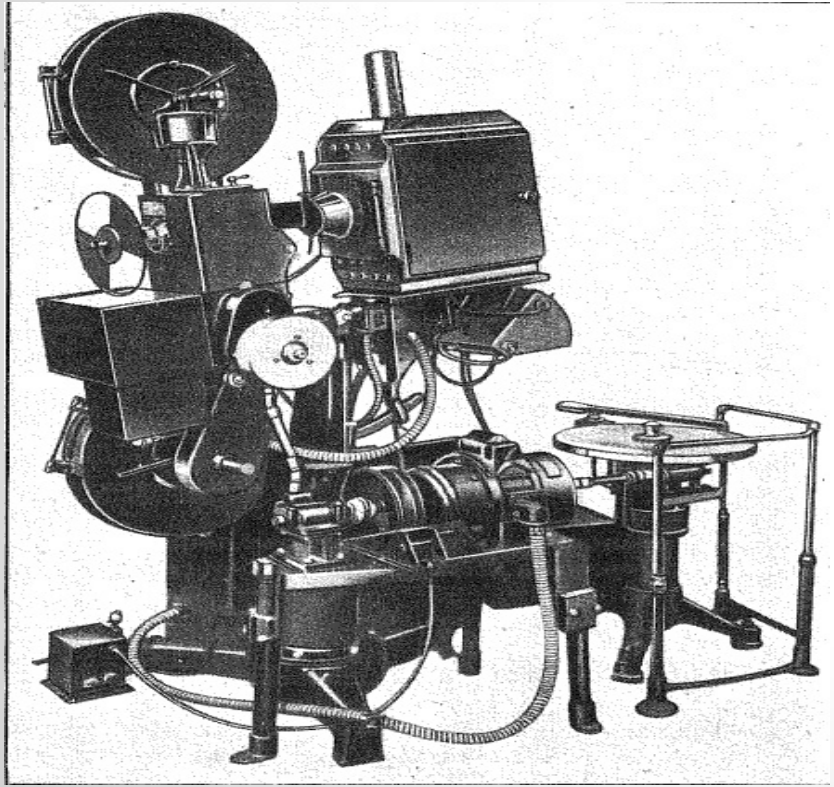


http://ftp.uslinc.com/ftp/Products/LSS-100P/Documents/Technical/ColorMeasurement/ColorMeasurementLSS_150130.pdf

1916 - Technicolor invented

Two color (red, green) additive simultaneous process. Image is frame from 1917 movie *The Gulf Between*

1926 - Vitaphone adds sound



Vitaphone played sound on a 33 ⅓ RPM phonograph disk run by the projector motor to sync sound with image.

Sound on Film

A patent for sound on film (along with the image) was issued in 1907 to Eugene Lauste, who had worked in Edison's lab. Optical sound was read with a photocell, invented by Hertz in 1887. But, the amplifying feature of the Audion tube (invented in 1906) was not widely known, so the sound on film could not be played to a large audience.

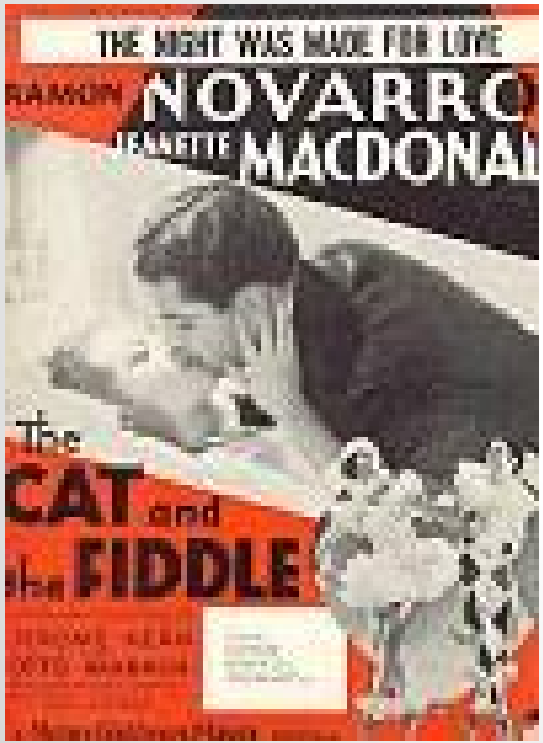
1923 - Commercial Sound on Film

Lee De Forest (inventor of the Audion tube) presents the first commercial sound on film movie. Many others throughout the world doing similar work.

1926 - Frame rate set to 24fps

Silent films had been 18 to 23 frames per second, often varying through the movie. Sound on film required a constant speed to avoid pitch changes. 24 was chosen. 24fps gives smooth motion, but visible flicker. To reduce flicker, each frame is flashed on screen 2 or 3 times.

1934 - First 3 color movie released

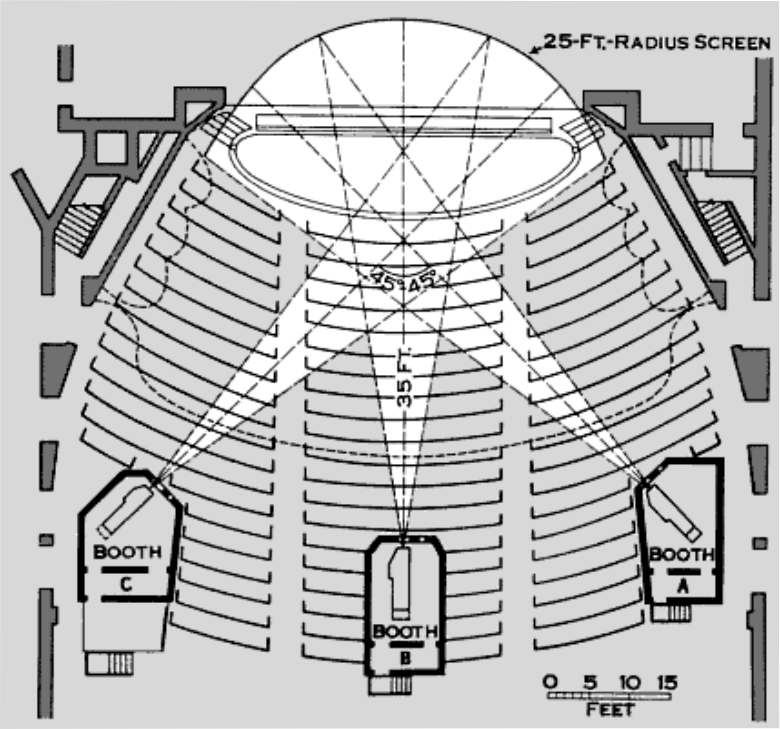


Technicolor 3 strip process. Shot on three strips of black/white film with filters. Printed with dyes to single film for projection.

1940 - Multitrack Sound

Fantasia had sound on a separate 35mm film run in sync with the image film. Sound was recorded magnetically as 3 tracks.

1952 - Cinerama



Three synchronized 35mm projectors for very wide image plus fourth synchronized 35mm strip with 7 tracks of magnetic sound.

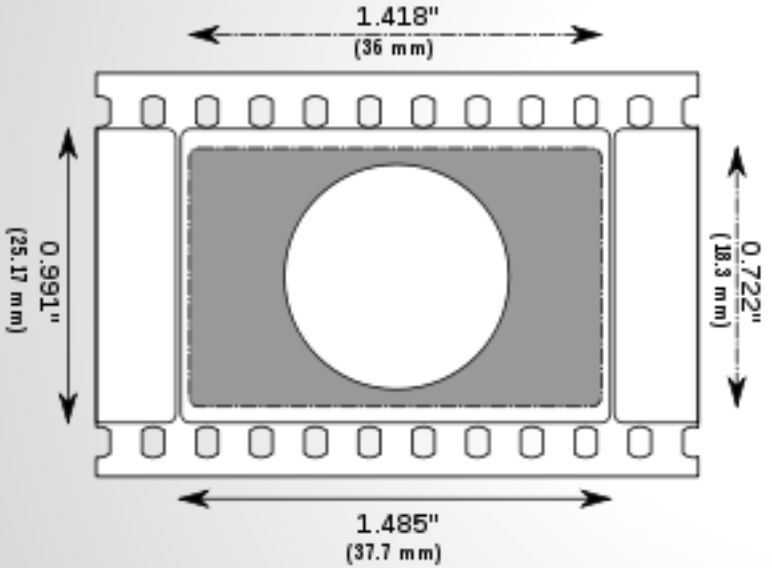
1952 - 3D

Warner's "NaturalVision" used two synchronized 35mm projectors and Polaroid filters to separate right and left eye images.

1953 - Cinemascope

To compete with Cinerama and television, 20th Century Fox used an anamorphic lens to squeeze a wide picture onto 35mm film.

1954 - VistaVision

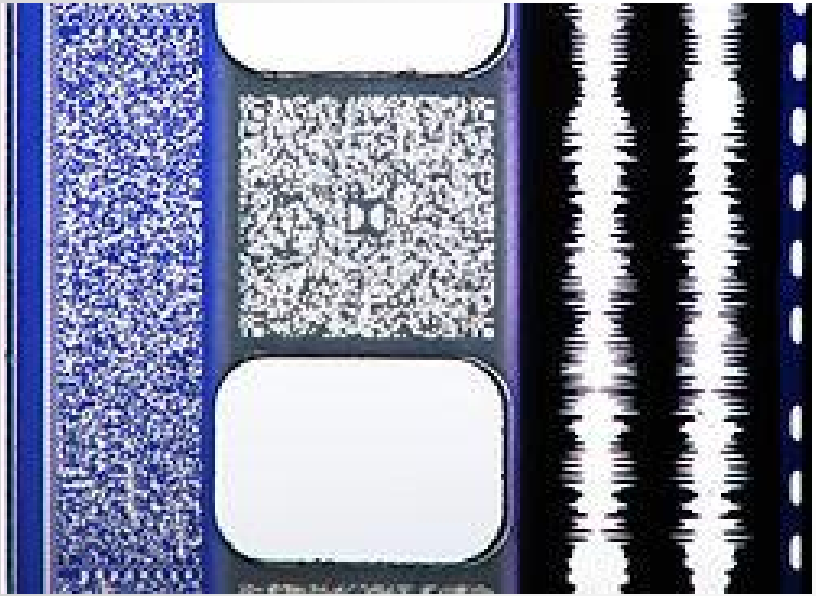


Paramount cleverly makes wide screen movies by turning the film, camera, and projector sideways. Technique later used by IMAX and OMNIMAX.

1976 - Dolby Stereo

Two analog optical tracks with noise reduction decodes to left, center, right, and surround. 1977 Star Wars was first major movie in Dolby Stereo.

1990s - Digital Sound on Film

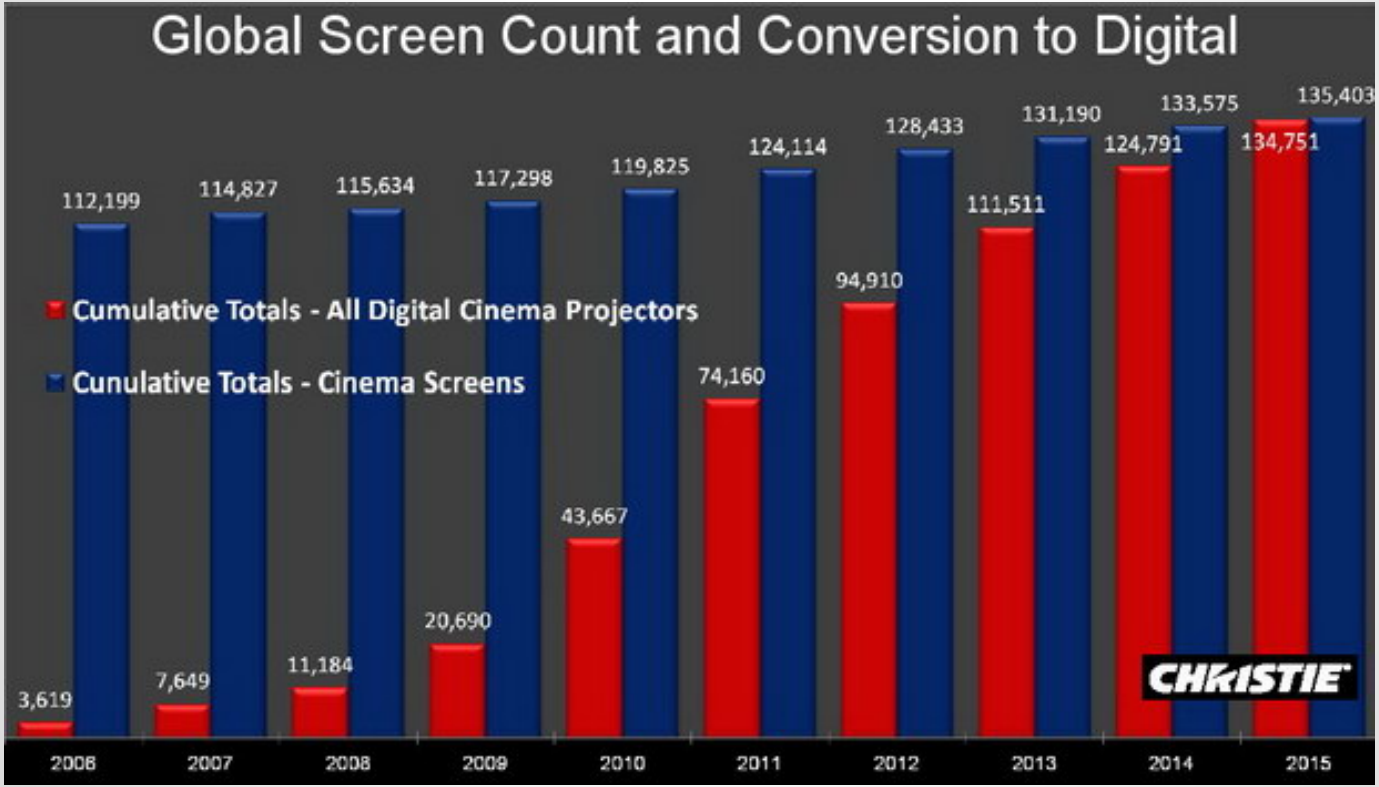


Sony SDDS on left, Dolby Digital between sprocket holes, analog stereo, then DTS timecode on right.

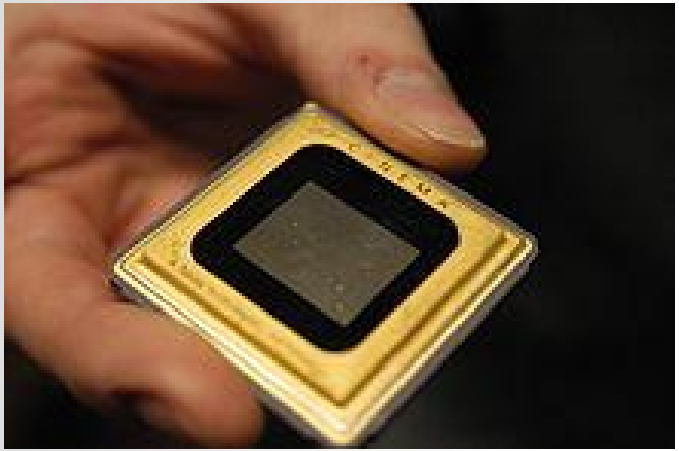
Digital Cinema

the (almost) end of film.

Cinema conversion to digital

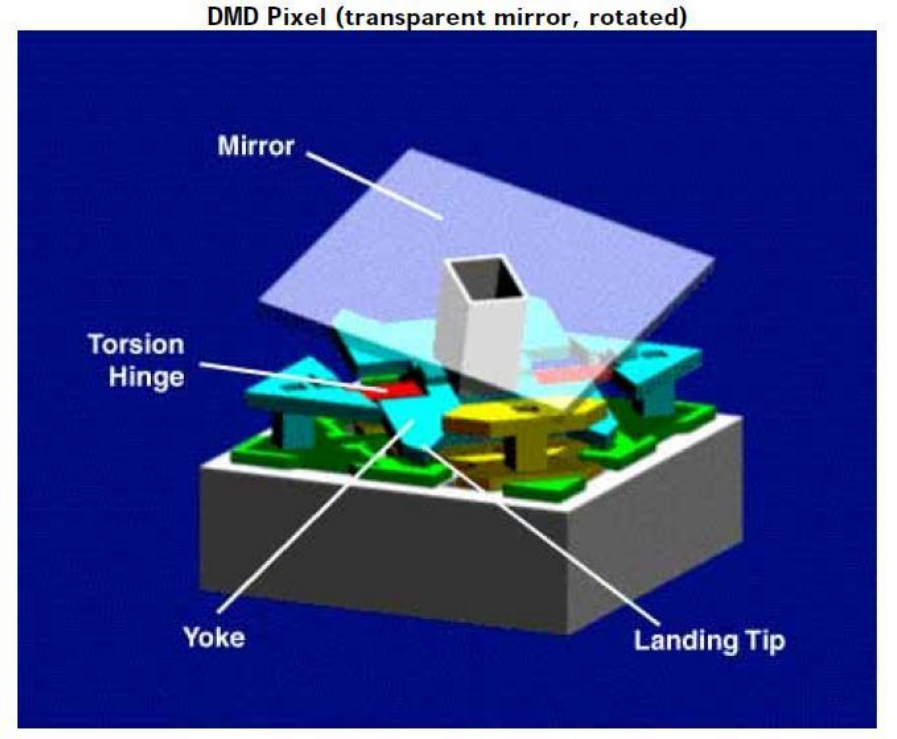


1998 - Digital Light Processor



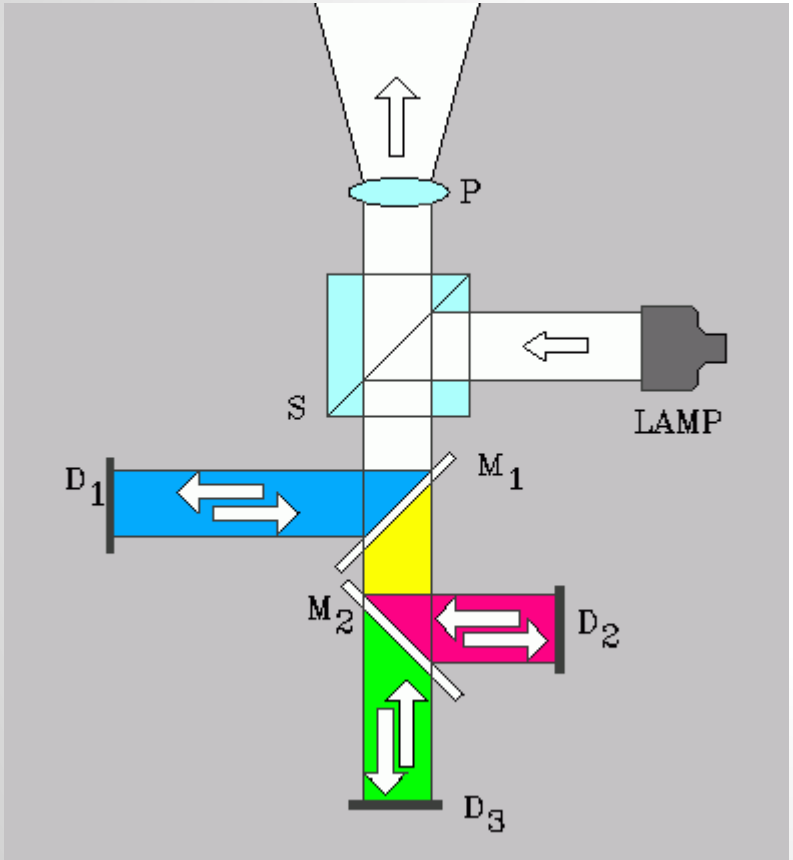
Up to 8,847,360 micromirrors direct light to screen or heat sink. Cinema projectors use 3 of these chips.

DLP Pixel



Mirror swings +/-10 degrees in response to electrostatic charge on circuitry beneath. Each pixel is 16um square.

Three DLP chips for color image



Currently using several thousand watt xenon lamp.
Experimental projectors using lasers or laser and phosphor.

LCoS

Most projectors use DLP, but Sony uses Liquid Crystal on Silicon. Similar to DLP, LCoS is reflective instead of transmissive. As with other liquid crystals, light intensity (reflection) is varied by changing polarization of light to be aligned with another polarizer or not. Difficult to get as good linearity as DLP.

Picture Resolution

- Most movies and projectors are 2k (2048 x 858 pixels for scope aspect ratio and 1998 x 1080 for flat aspect ratio).
- Some movies and projectors are 4k (twice as many pixels wide and high, or 4 times as many pixels total)

Color Depth

Each primary color is encoded as 12 bits per pixel (36 bits per pixel total) for 4,096 different levels. 4096*4096*4096 possible colors for each pixel.

Blu Ray uses 8 bits per color (24 bits per pixel total).

High Dynamic Range

Experimental systems increasing the dynamic range of the image (brighter whites, darker blacks).

Digital Sound

Most movies are distributed as 5.1 or 7.1DS sound with 48kHz sample rate, 24 bits per sample. CDs use 44.1kHz sample rate with 16 bits per sample. Dynamic range of movie sound is 48dB more than CD.

Accessibility

- Hearing Impaired Audio.
- Audio Description
- Captions
- Subtitles

Movie Data Format

- JPEG (not MPEG) images
- Image data rate up to 250Mbps
- Up to 16 channels of 24 bit sound, 48kHz or 96kHz sample rate, no compression
- Most delivered on hard drives
- In US, about 18,000 screens (of about 40,000) receive movies by satellite

Security

- Movies are encrypted
- Keys permit playing on specific projector/server combinations on specific days and times.
- Audio and image forensically marked during playback to identify auditorium and time movie was pirated.

Economics

- Each film print costs over $1,000 to print and ship.
- Digital movies cost less than $100 to copy and ship (even less by satellite).
- Much of digital conversion financed by “Virtual Print Fees” where studios paid for equipment with savings of not making prints.
- $50k to $100k to convert screen to digital

3D

- Real D - Polarized light, alternating or simultaneous images. Requires silver screen.
- Dolby - Spectral split, alternating or simultaneous images
- XpanD - Shutter glasses, alternating images

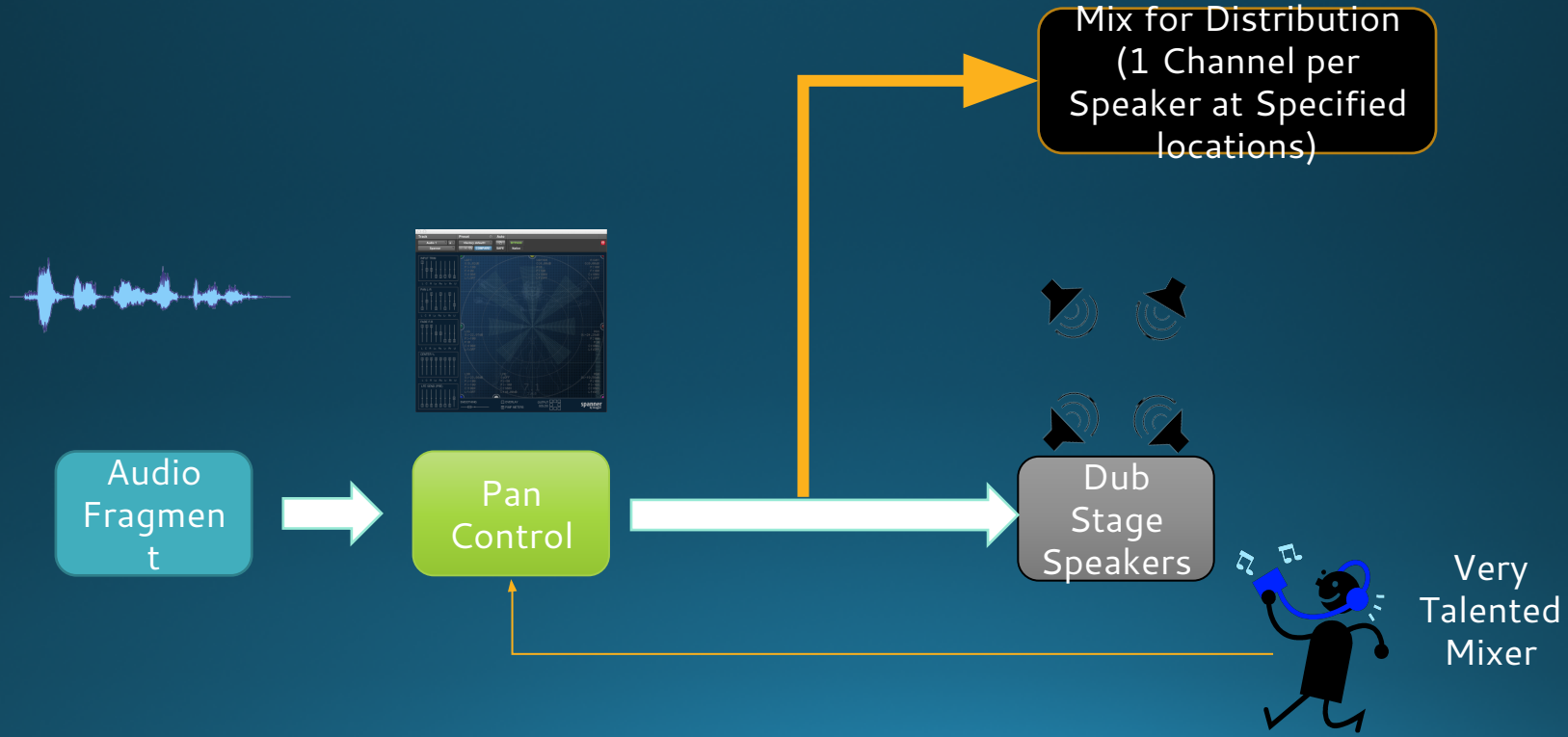
4D

- Seat shakers use special digital track on movie to move seat in sync with movie action. Most common system is Dbox (Galaxy Atascadero has system)

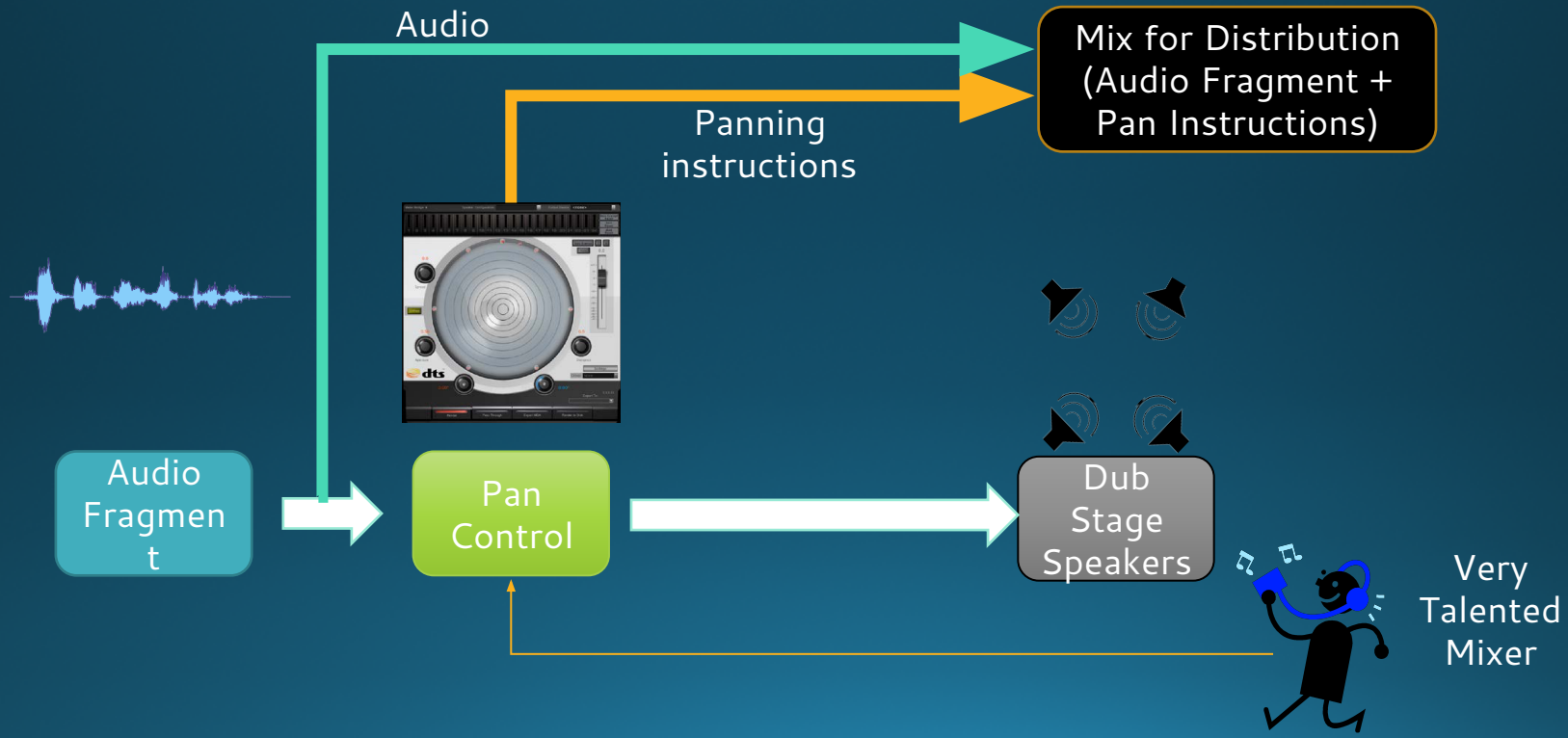
Object-based sound

- Major system is Dolby Atmos.
- Competing system is DTS MDA (also known as DTS-X).
- Sound fragments plus panning instructions are in movie. Playback system “renders” sound to speakers in auditorium (typically up to 64).

Channel Based Mixing



Object Based Mixing



High Frame Rate

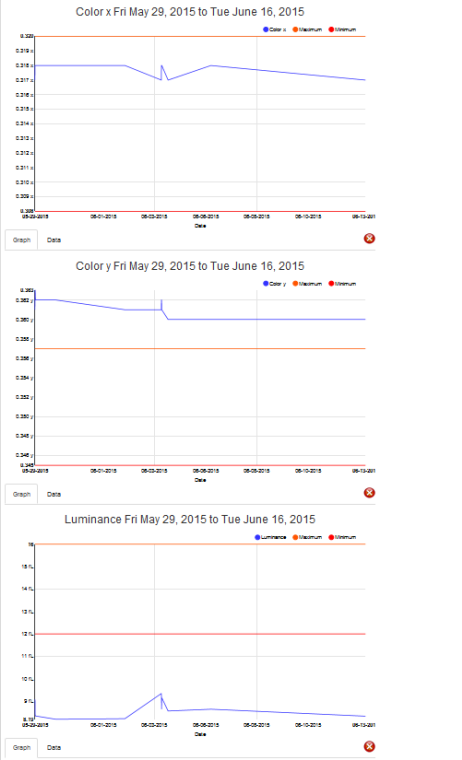
Two Hobbitt movies released in 3D HFR (48 frames per second per eye). Smoother motion and less motion blur. Director says “It’s like looking out a window.” Detractors say “It’s like watching TV.” Does HFR make movies less “cinematic?”

Live Events

Network Operations Center

Large chains can monitor theater operations and fix problems remotely. Contract NOCs serve smaller theater groups.

Quality Control



LSS system automatically measures luminance, color, sound on all speakers. Results posted to central database for analysis and reporting. Currently installed on about 5,000 screens.

Digital Cinema Server (internal)

Digital Cinema Projector

End of Film?

Almost, but not quite. Film, especially 70mm still has better image quality (until it gets scratched). Digital has high and consistent image quality. Will continue to improve. Some directors still insist on shooting and distributing on film (Quentin Tarantino does film distribution first, then digital later).

Thank you!

Comments?

Questions?

Complaints?

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