



helps companies find growth opportunities, create winning strategies & business plans in the digital entertainment value chain.

Services include strategic consulting and market analysis with an understanding of the industry value chain and technologies.

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# Digital 3D

## From Theater to Home Why Now & How it Works

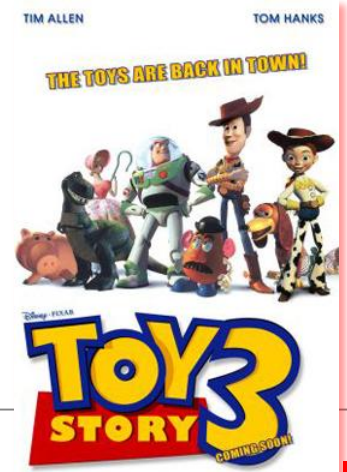


Rev B Image: Pocoyo

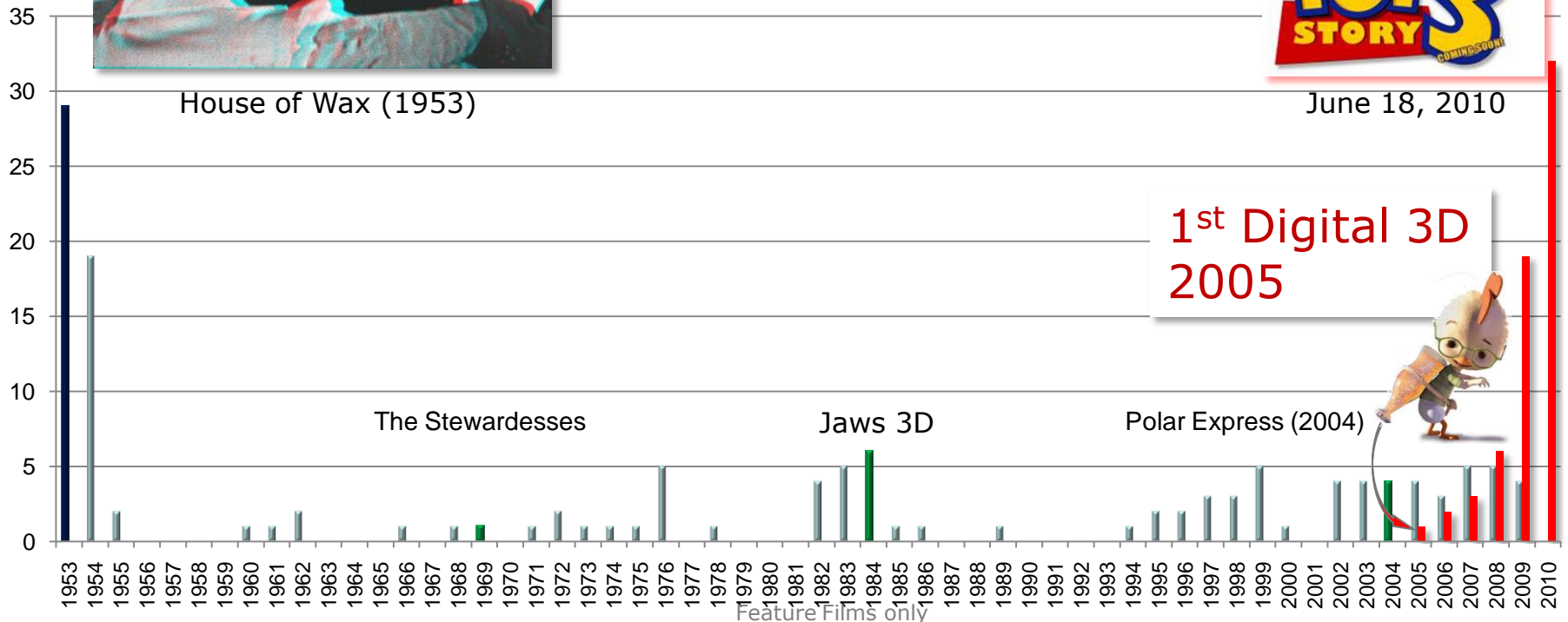
# Why Now & Why This Time?



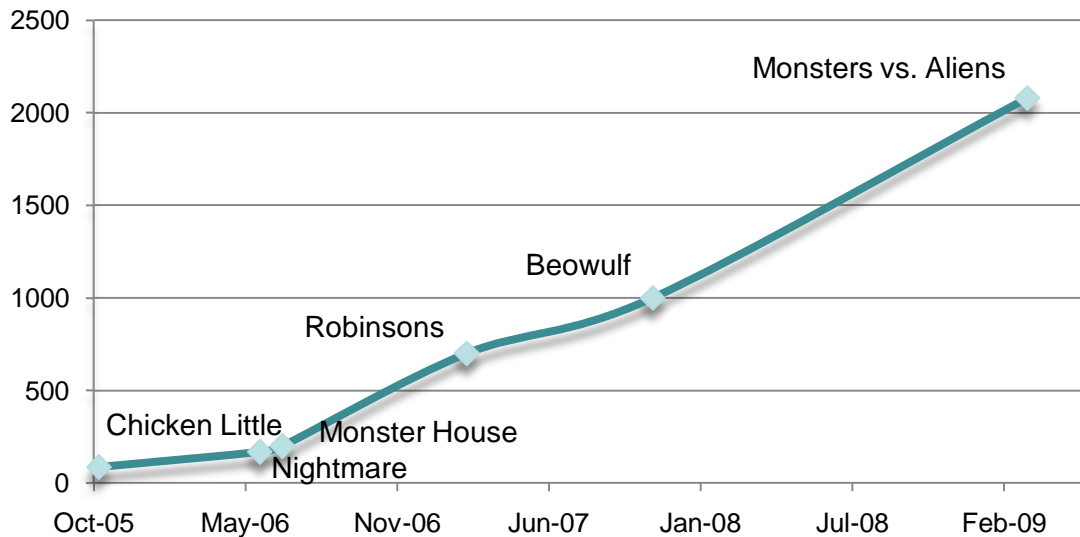
House of Wax (1953)



June 18, 2010



# The Number of 3D Screens Grow



There are about 5,000 3D screens  
Worldwide (June 09)



\$60M B.O. (as of 9/25)  
#1 for first two weeks

IMDbPro

# Digital Cinema Enabled 3D

But, 3D is now a Catalyst for Digital Cinema

- Monster House (2006) – x 4 2D Box Office
- Beowulf (2007) – x 3.1, (x 12 in Russia)
- Hannah Montana (2008) - x 3.9\*
- Journey to the Center of the Earth (2008) – x 3.7
- Monsters vs. Aliens (2009) – x 3.1

3D Screens typically demand \$3.50 to \$5 premium over 2D

Live 3D Events go for 2x to 5x normal ticket prices,  
sell more concessions,  
and put butts in seats mid-week.



\* Estimated multiple based on comparison with *High School Musical 3* (2009). (IMDbPro)





# The Theater



Theater in  
Eindhoven, NL

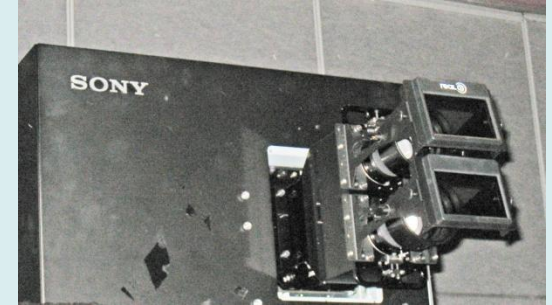
# The 3D Projector - Polarized



Standard RealD



RealD XL



RealD w/Sony 4K



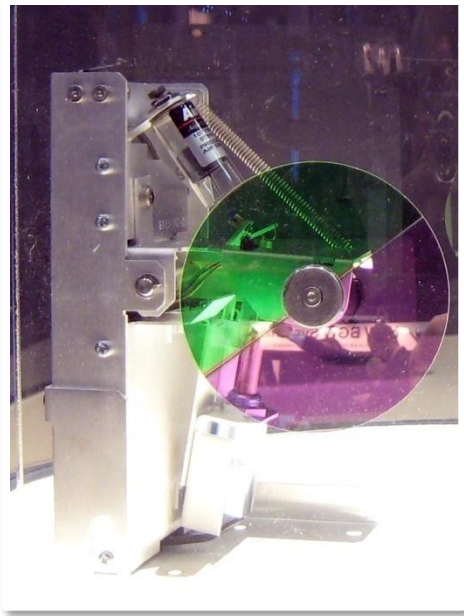
masterImage

- Circularly polarized (head can tilt)
- Silver screen to preserve polarization
- RealD XL – uses wasted light - 30% efficient
- RealD Sony 4K – overlays two 2K images
- masterImage
- Xpand – uses active glasses

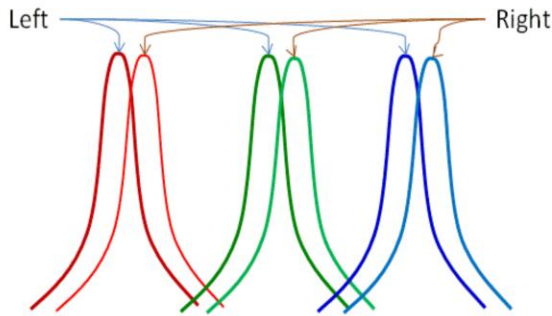


Xpand

# The 3D Projector - Spectrum

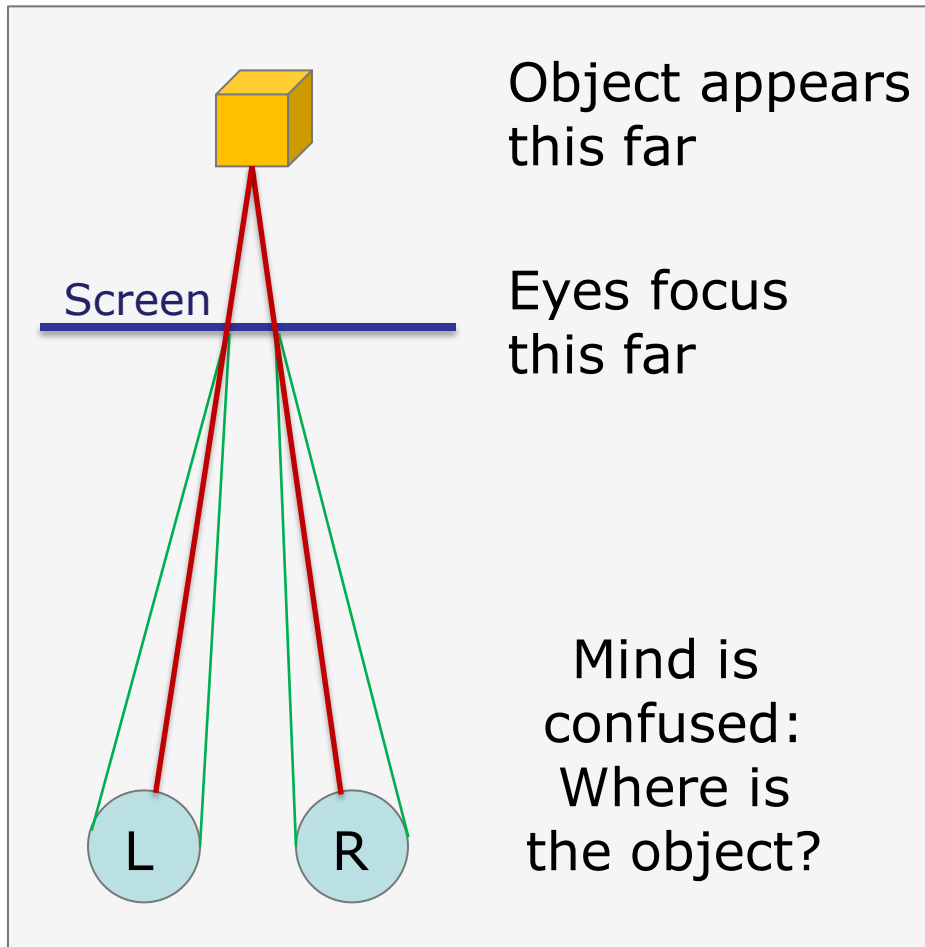


- **Dolby** puts spinning filter between light and DLP to offset RGB
- Existing Matte White screen can be used
- Glasses use 50-layers of film and are more expensive (~\$23)
- Glasses are washed and reused
- Slightly less **ghosting** than polarized system
- ~15% efficient





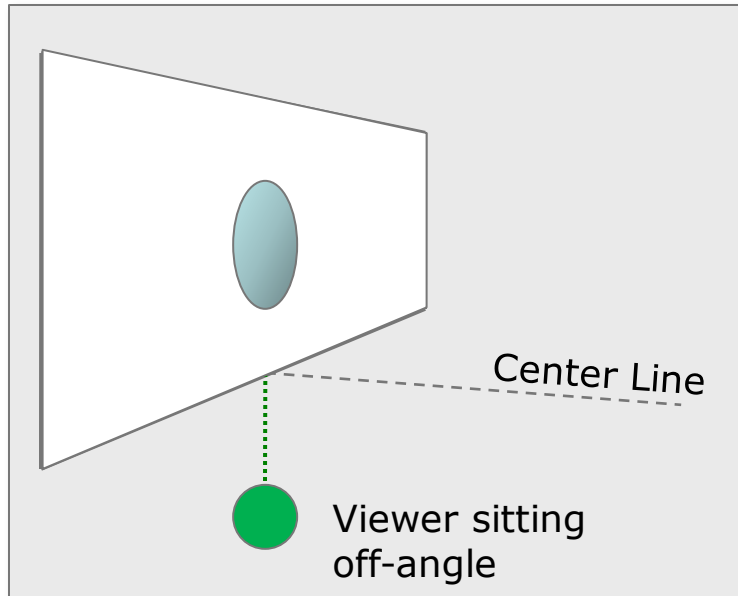
# Vergence Accommodation Conflict



Marty Banks, Univ. of Calif. Berkeley study

- A prime source of eye strain (headaches)
- Percival's Zone of Comfort is subjective acceptable VAC range
- Theory: if conflict times are kept short, strain is minimized.
- Images can be "adjusted" to minimize this problem. GPU is needed in Post or in Real Time.

# Keystone Perception/Correction



Marty Banks, Univ. of Calif. Berkeley study

- The mind corrects for keystone distortion when viewing a 2D picture.
- The mind does not correct for this distortion when viewing a stereo 3D picture
- Is there an opportunity here?

# Luminance

## Issue:

- 3D optics throws away light
- SMPTE suggests 15 Ft-L luminance
- Most 3D projection are closer to 3 Ft-L

## Solutions:

- Adjust Image Color in Post and/or with LUTs in projector
- Mechanical solutions:
  - Use higher gain screen
  - Crank up the bulb (shorter life)
  - Use smaller screen (<40')
  - Use optical doubling



Barco stacked projectors

LUT = Look Up Table  
Ft-L = Foot Lamberts

# 3D Sound Systems



IOSONO in Mann 6 (L.A.)  
380 speakers

Sound can be 3D, too.

IOSONO system creates  
32 virtual sound sources for  
each seat in the theater

Audio may be a  
different kind of application  
for GPU technology

# Live 3D Alternative Content

## NBA All Stars



3ALITY Cameras



Turner Production Truck  
3ality/Quantel Postproduction  
Sensio encoding

IDC Satellites



Cinedigm  
Theater  
Network



IDC/Sensio Receiver



Doremi Server

86 Screens

Christie  
& RealD



\$20/Seat + Beer (one example)



# Live 3D Ads & Games



3D Advertisements are starting to show up.

Generating such images during a live event can be a GPU challenge.

Live 3D Games in Theaters



**CREATURE FROM THE BLACK LAGOON**

**RICHARD CARLSON · JULIA ADAMS**

**RICHARD DENNING · ANTONIO MORENO**

**NESTOR PAIVA · WHIT BISSELL**

WRITTEN BY REX BEHREND · SCREENPLAY BY HAROLD LLOYD · DIRECTED BY WILLIAM ALLAND · A UNIVERSAL INTERNATIONAL PICTURE



# Cameras

Cameras may have Adjustable or Fixed:

- Convergence
- Interocular



3ALITY

(Sony cameras)



Convergence  
Interaxial



21<sup>st</sup> Century 3D  
(Panasonic cameras)



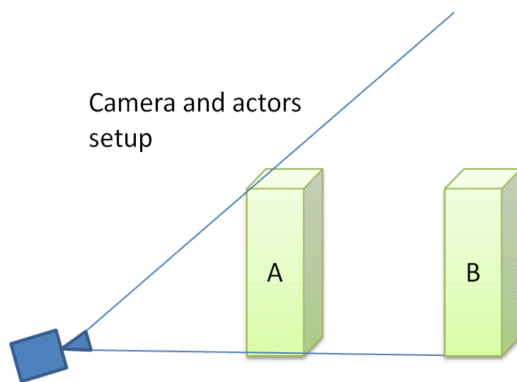
# False Perspective Issue



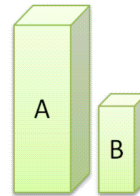
Q: How do you get a 5'6" Elijah Wood to look like a 3'5" Hobbit while standing next to the 5'11" wizard played by Ian McKellen?

A: Use False Perspective

But, with 3D cameras, False Perspective doesn't work



As seen on 2D screen



So, one can use  
**Dimensionalization**

# Post



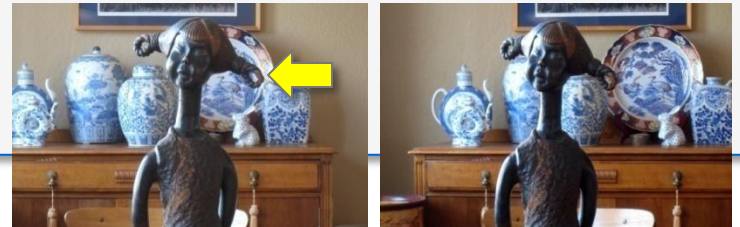
Da Vinci Digital Intermediate Station



# Dimensionalization

2D movies can be made to look 3D

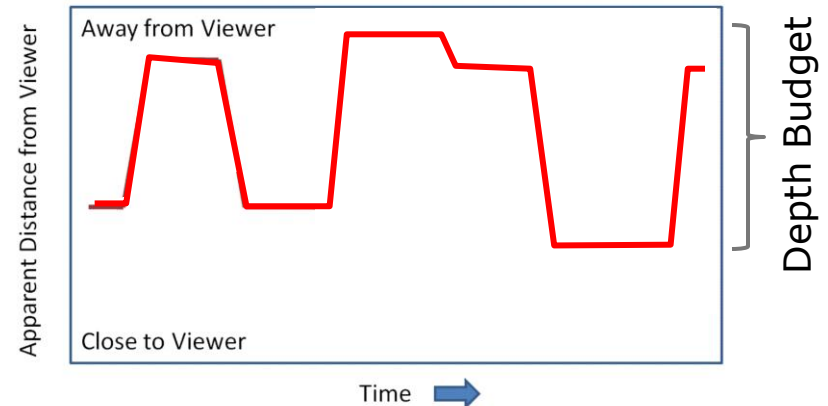
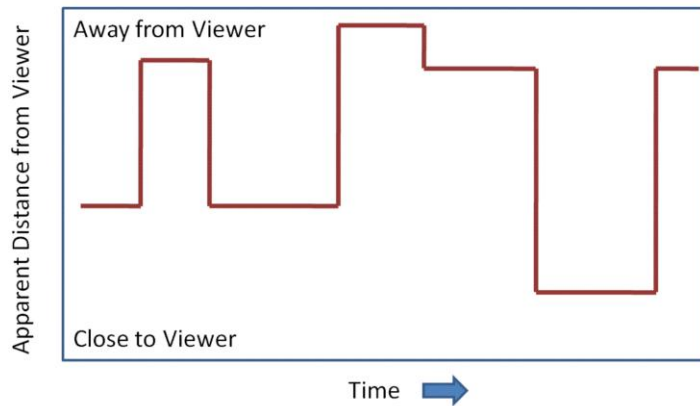
1. Each object is digitized
2. Objects are “moved” forward and back as Director wishes
3. Closer objects are given depth and shape as needed
4. Hidden images are reconstructed
5. Final adjustments are made



Dimensionalization is perhaps the most challenging imaging task.  
Many steps are semiautomated,  
but improvements still are needed.

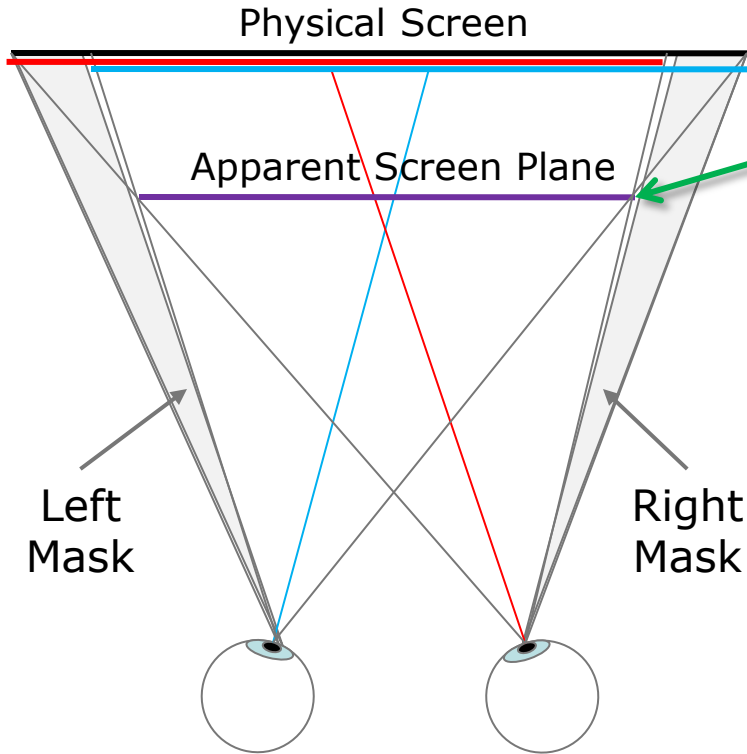
CGI = Computer Generated Imagery

# Depth Budget & Grading



- DPs and Editors need to avoid rapid extreme depth changes to avoid eye strain
- Older people take longer to adjust
- “Fading” between depths can help
- “Depth Grading” in Post can help
- Can be challenging for 3D Live events
- Automated tools are still needed.

# Floating Window



Masks are exaggerated to show process

## Floating Window

- Avoids L-R image conflicts at the sides
- Image is floated towards viewer
- L image masks left side; R image masks right side.

Opportunity: Imaging tools  
to help manage  
Floating Windows.

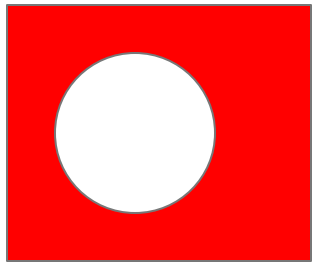
# Ghosting



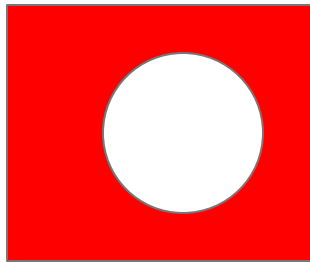
- “Ghosting” or crosstalk between L & R images is most evident in high contrast areas of a scene.
- Polarized systems have the most ghosting, but other systems have ghosting, too.

Most ghosting can be removed by a “ghost-busting” step.

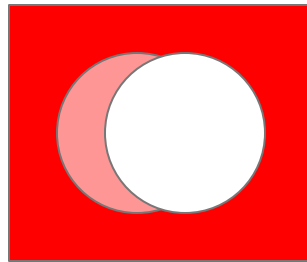
Colors are adjusted on one image to offset crosstalk from the other image.



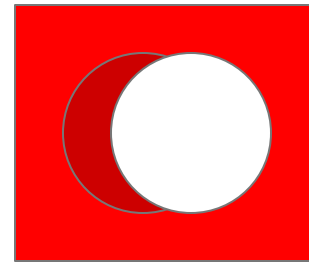
Before L



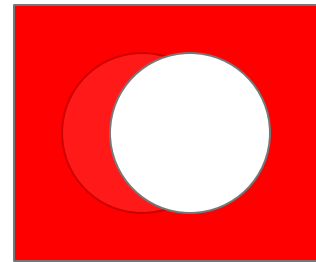
Before R



Before L+R  
seen from R eye



Ghost-busted R  
(L is also ghost-busted)



After L+R  
seen from R eye

# Post Tools



Quantel 3D Station

- Editing and DI tools are 2D oriented with shoehorned 3D features
- Tools designed with 3D in mind are just starting to appear

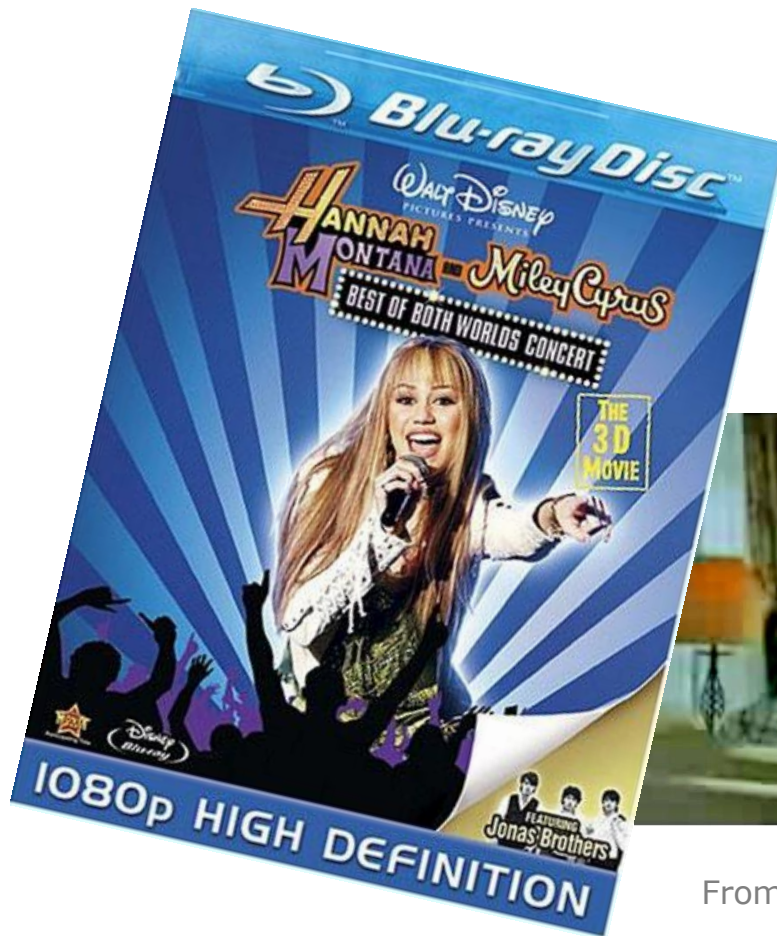
- Animation tools are mostly custom (example RenderMan, **Pixar**)



Render farm at **ILM**



# Home

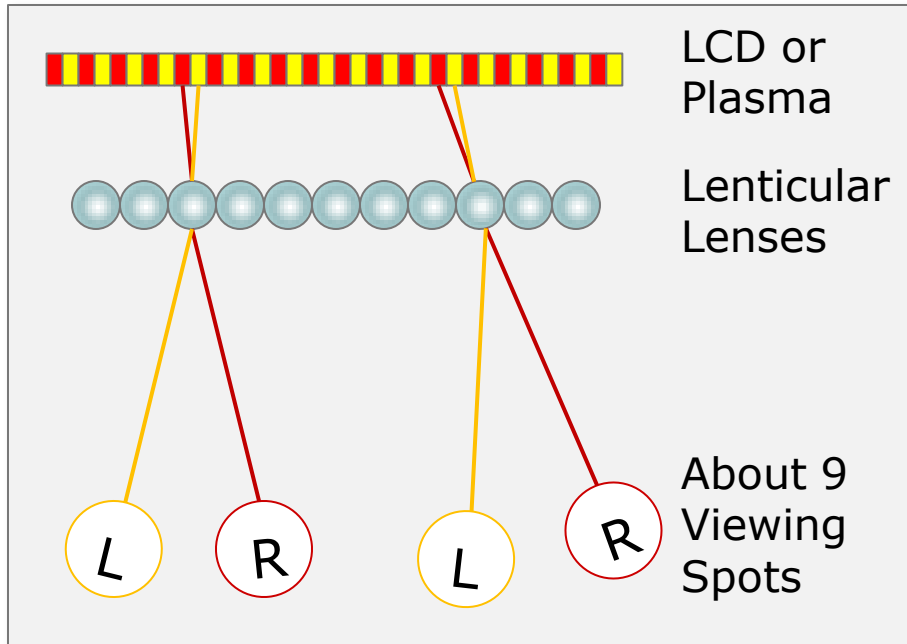


From Hannah Montana 3D Blu-ray trailer

# 3D TV

	DLP Active Shutter	Plasma Active Shutter	LCD Active Shutter	LCD Micro Polarized	DLP Projector Active Shutter
Samsung	✓	✓	✓		
LG		✓			
Mitsubishi	✓				
Hyundai				✓	
Panasonic		✓			
Sony			✓	✓	
ViewSonic			✓		✓
InFocus					✓

# Autostereo 3D TV



- Philips licenses their **Lenticular Lens** system to a number of display companies (but no longer markets their own 3D displays)
- **Alioscopy** also has a Lenticular Lens system for their own displays

These displays are used primarily for Digital Signage.  
Example: 3D Movie Ads in Theaters

Live Interactive 3D Digital Signage is coming

# 3D PC & Games

- 3D computer monitors are used for Games and Industrial applications
- As 3D content becomes available\* on the web, people will watch 3D videos from their PC
- When can we expect 3D Web-to-TV?

\* 3D anaglyph [YouTube](#) already exists



nVidia RF actuated Active Shutter Glasses



ViewSonic 120 Hz LCD

Sony PS 3



# 3D Eyewear



- Yes, 3D wearable displays exist, but they have always tended to be seen as too geeky to wear.
- Sony and others are trying to make wearable displays fashionable.

Tom Hanks  
with [Sony](#)  
wearable 3D displays.

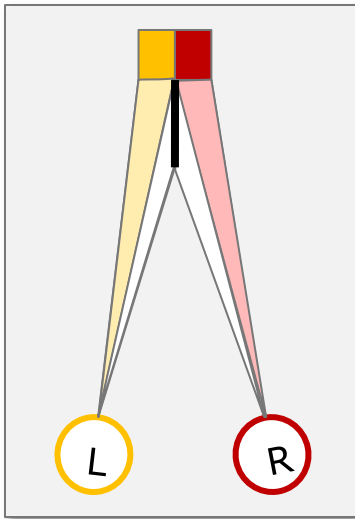
Viewer sees 3D images  
and what is around them





# Mobile 3D

- 3D displays on phones and portable TV devices exist
- These displays are auto-stereoscopic 3D using “Parallax Barrier”, which is good for only one viewer
- Fujifilm is introducing a 3D camera & picture frame, and is said to be working on a printer for making lenticular prints
- Challenge is GPU vs. power



ETRI 3D  
DMB Receiver



3Dinlife  
Digital Frame



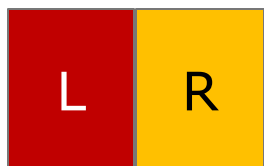
Fujifilm 3D Camera

# 3D Formats to the Home

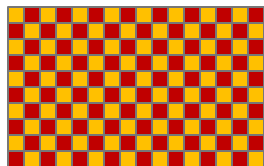
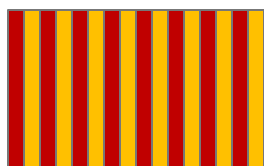
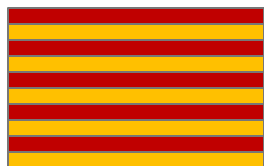
## Spatial Compression



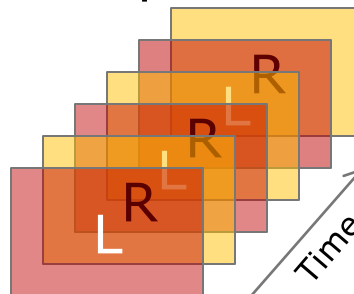
Not used



Micro Polarized



## Temporal Compression



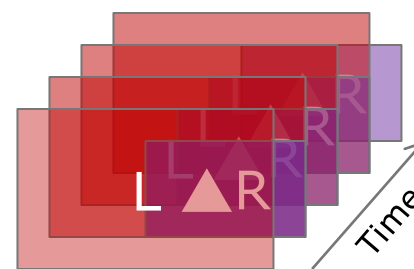
100% Bandwidth,  
50% Resolution

## Anaglyph



100% Bandwidth,  
Distorted Image

## 2D + Delta (Metadata)



140 to 170%  
Bandwidth,  
100% Resolution  
(or some compromise)

GPU must  
Encode and Decode

# Display Size vs. Interocular

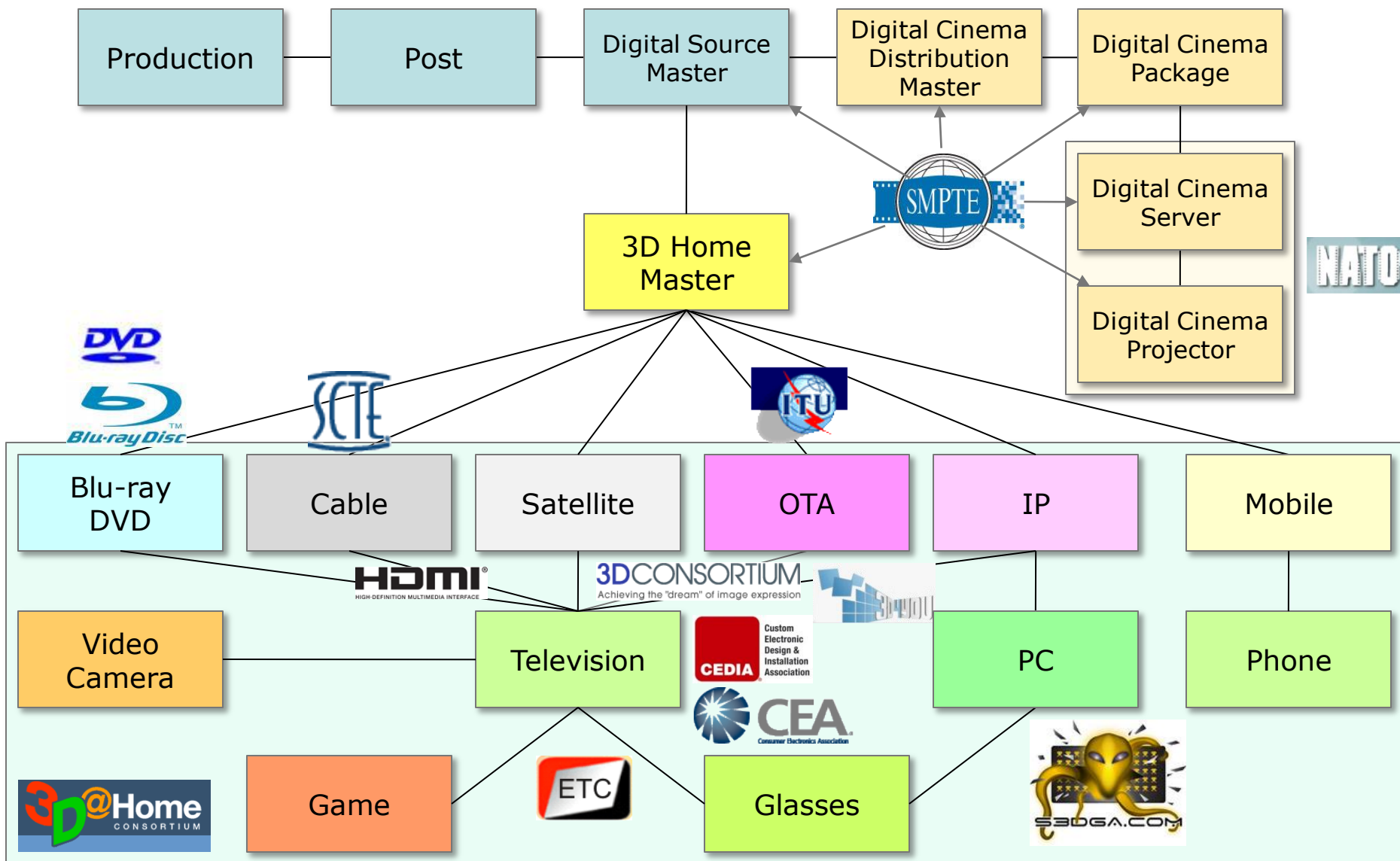


How best to compensate content for screen size?



Interocular Image adjustments may be needed in real time.

# Some Home 3D Working Groups





Services include strategic  
consulting and market analysis

A report will be available on  
3D at:

**[digdia.com](http://digdia.com)**

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