



ETC®  
Entertainment  
Technology Center



# Art, Technology, and Business of 3D Entertainment

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# The Entertainment Technology Center @ USC



# Agenda

1. 3D Content Creation
2. 3D in Movie Theatres
3. 3D TVs
4. 3D on Smaller Devices
5. What's Coming
6. Research Areas of Interest

# Agenda

1. 3D Content Creation
2. 3D in Movie Theatres
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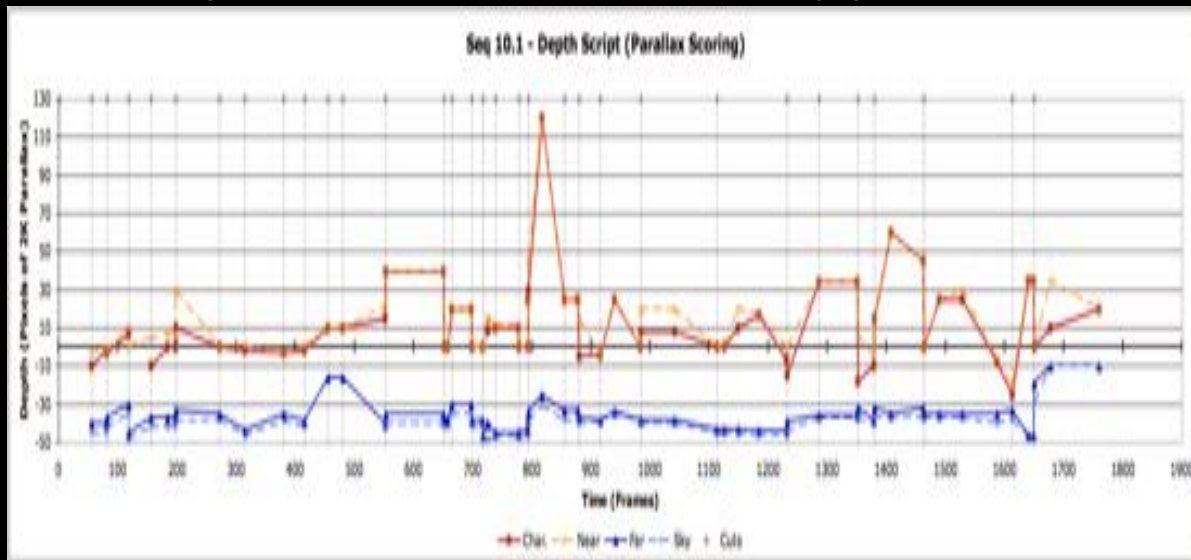
# Planning

- How will 3D affect storytelling?
- The 3D “Look”
- Production Design
- Depth Scripting



# Art of S3D

Some new 3D tools and techniques will emerge  
Entrepreneurial Creative Opportunities



depth script



3D Previsualization

# Shooting 3D - Lessons learned

Robert Neuman, Disney - film

“We discuss the 3D shot that we want and work backwards to achieve it with the technology”

Chuck Pagano, ESPN - sports

“It is a new perspective and a new approach.  
More sideline shots. Less high distance shots.  
Our people need to think in a different geometry.”

# Content Creation

1. Computer Generated Images (CGI)
2. 2D-to-3D conversion
3. Live Action (2 image)
  - Prerecorded
  - Real time





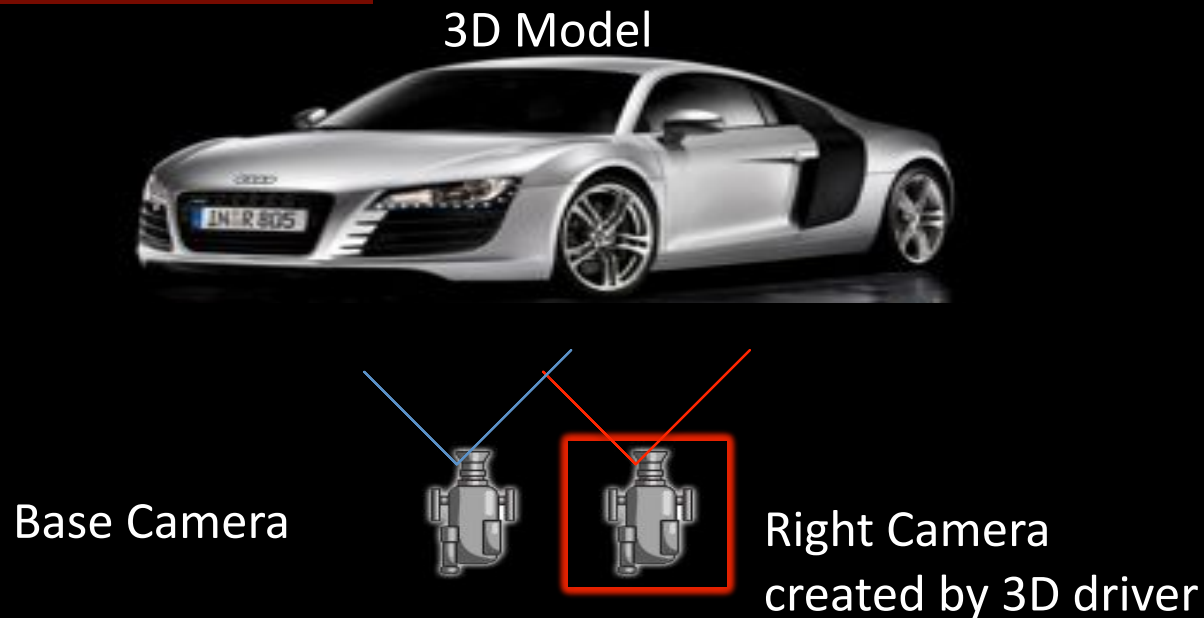
# Computer Generated Images (CGI)

- Everything is controlled
- No alignment issues



# Games (the other CGI 3D)

- Adjustable S3D



# Games (the other CGI 3D)

- Adjustable S3D

- Average gamer is 34 years old
- Average gamer has been playing for 12 years
- 40% are now women (prefer social games)

Source: Craig Allen, CEO, Spark Unlimited, 12/10 conversation

- Call of Duty: Black Ops- \$650M in 5 days (\$1B in 9 mo.)
- 50 3D games coming to PS3
- Nintendo 3DS may drive consumer adoption of 3D

# 2D to 3D Conversion

## Quality/Cost Tradeoff

Real-Time  
2D to 3D Conversion



Non-Real-Time  
2D to 3D Conversion

- Painters
- Human hands



Native 3D

- Two  
Cameras



*Conflicting depth cues*

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## Real Time 2D-3D Conversion

3D Eye Solutions  
3D Mention Media  
ArcSoft  
CyberLink  
DDD  
e-MDT  
Enhanced Chip Technologies  
Inc  
HD Logic  
Himax Technologies  
Marvell  
Mercury Systems  
Panasonic (JVC)  
Quartics  
Sensio  
Sonic Solutions  
Stergen (Vizrt)  
Toshiba  
Trident Microsystems  
Wistron

## Non-Real Time 2D-3D Conversion

DDD  
In-Three / Digital Domain  
Legend Films  
Passmore Labs  
Prime Focus  
Sassoon Film Design  
Stereo Pictures  
Technicolor

Conversion is continuous 3D.  
You can control everything.  
- Phil McNally

7 cues

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# Live Action

- Two cameras or camera pairs
- Alignment issues



Beam splitter



Side by side

Limited min. interaxial



Single body

Limited interaxial range

Single or dual sensor

# Art of S3D

Sports and live action  
driving the learning curve

Camera development

Cutting among cameras

Stats, flying logos, and closed caption



# Shooting 3D - Lessons learned



Depth of Field  
circle of isolation  
makes telephoto ok



Close-up  
becomes  
Big-up



Sight lines

# The Emerging Language of 3D

## End Game:

To transition 3D  
from a special effect  
to a key resource in the storyteller's tool kit



As the audience learns the conventions,  
the language of 3D will evolve

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# Leading 3D cinema systems



**RealD (polarized)**



**MasterImage (polarized)**



**Dolby (color shift)**



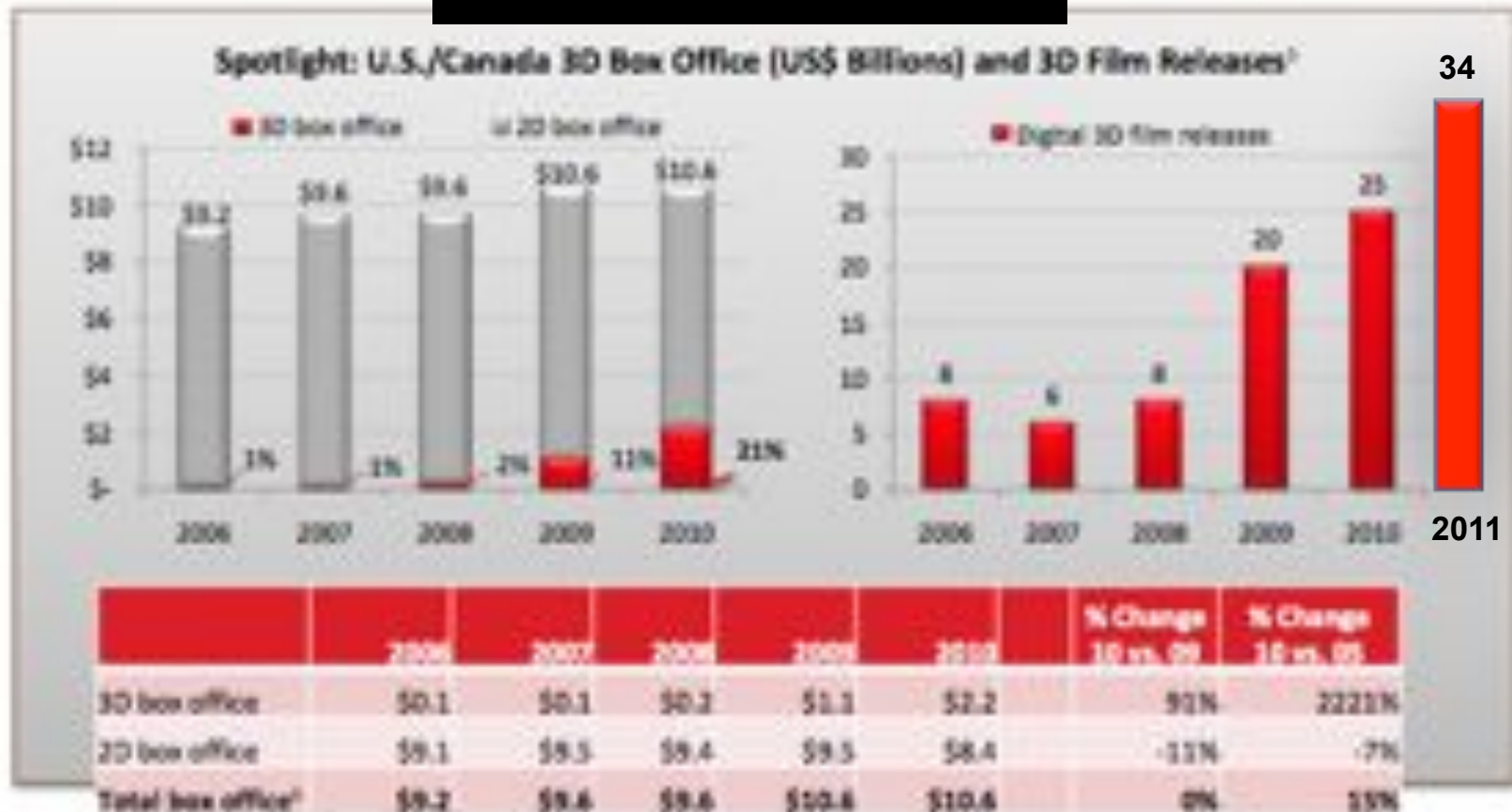
**XpanD (active shutter)**

# Screen Count as of March, 2011

	U.S.	World Total
Digital Screens	16,231	39,742
<b>3D-capable</b>	<b>8,963</b>	<b>26,022</b>

China averages 3 new screens/day!

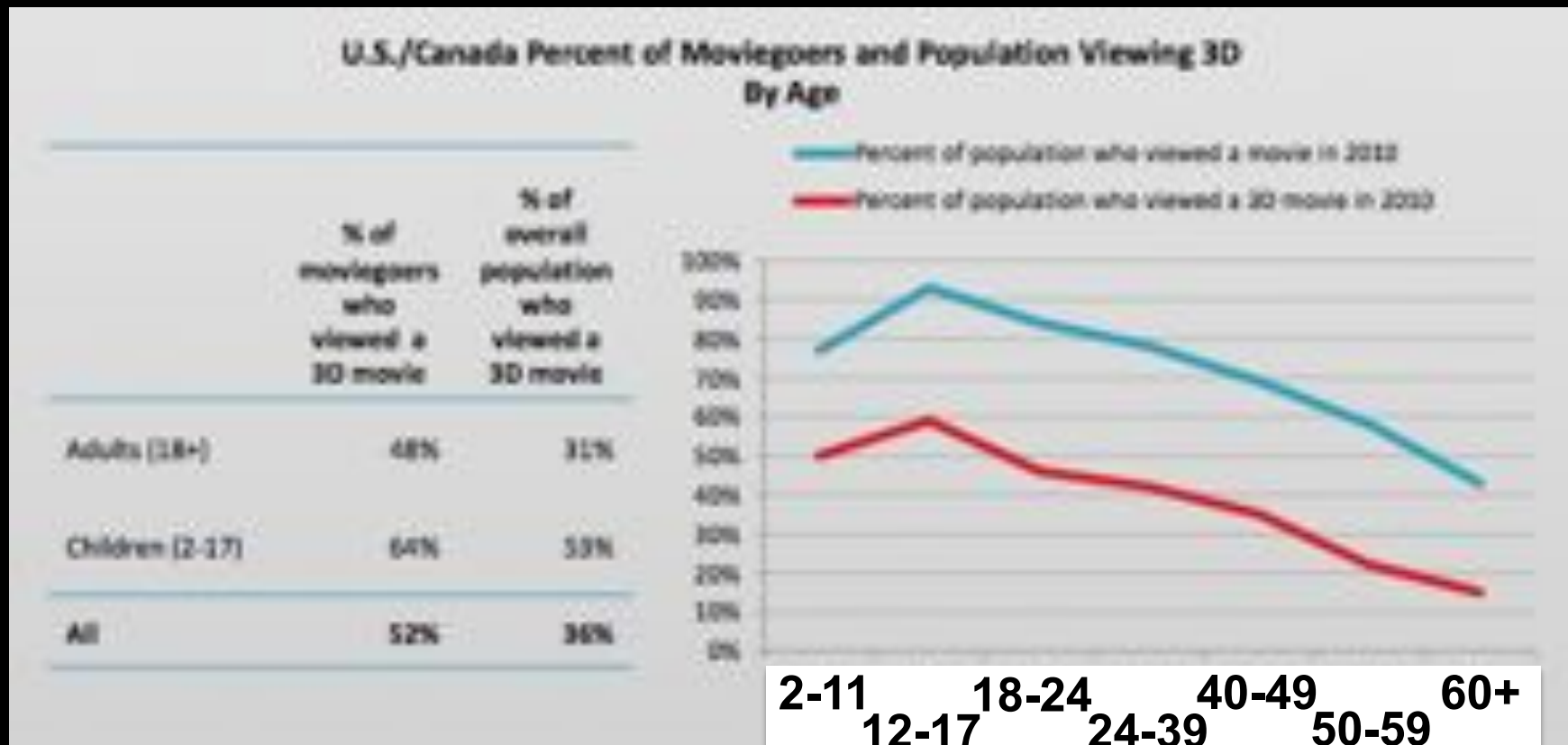
# Theatrical 3D



<sup>1</sup> MPAA calculates 3D box office and release numbers based on data from MPAA member studios and from IHS Screen Digest. Includes only box office earned from 3D showings, not total box office for films with a 3D release.

<sup>2</sup> Source: Rentrak Corporation – Box Office Essentials

# % of population by age who went to a movie in 2010 2D (blue) and 3D (red)



# Upcoming 2011 3D Releases

Not counting  
Bollywood  
International  
Independent

## UPCOMING RELEASES

Title (click to view)	Studio	Release Date
Green Lantern (in 3D)	WB	6/17/11
Cars 2	BV	6/24/11
Harry Potter and the Deathly Hallows (Part Two in 3D)	WB	7/15/11
Captain America: The First Avenger	Par.	7/22/11
The Smurfs (in 3D)	Sony	7/29/11
Final Destination 5	WB (NL)	8/12/11
Glee Live! 3D!	Fox	8/12/11
Spy Kids 4: All the Time in the World (in 3-D)	Wein.	8/19/11

Fright Night (in 3-D)	BV	8/19/11
Shark Night 3D	Rela.	9/2/11
Dolphin Tale 3D	WB	9/23/11
The Three Musketeers (2011)	Sum.	10/14/11
Puss in Boots	P/DW	11/4/11
A Very Harold & Kumar 3D Christmas	WB	11/4/11
Happy Feet 2 in 3D	WB	11/18/11
Arthur Christmas (in 3D)	Sony	11/23/11
Hugo Cabret (in 3D)	Par.	11/23/11
Piranha 3DD	W/Dim.	11/23/11

Alvin and the Chipmunks: Chipwrecked	Fox	12/16/11
The Adventures of Tintin: The Secret of the Unicorn (in 3D)	Par.	12/23/11
The Darkest Hour	Sum.	12/23/11

Source: [www.BoxOfficeMojo.com](http://www.BoxOfficeMojo.com)

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# 2011 3D Releases



ight (in 3-D)	BV	8/
ight 3D	Rela.	9/
Tale 3D	WB	9/
ee Musketeers	Sum.	10/

Captain America: The First Avenger	Bar	3/23/11	Puss in Boots	P/DW	11/4/11	Chomunks:	Fox	12/16/11
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Werner Herzog: **Cave of Forgotten Dreams**  
(3D documentary)

Bernardo Bertolucci is working on *Io e Te (Me and You)*  
(3D Drama)

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12/23/11

12/23/11

26



# Are audiences tiring of 3d?

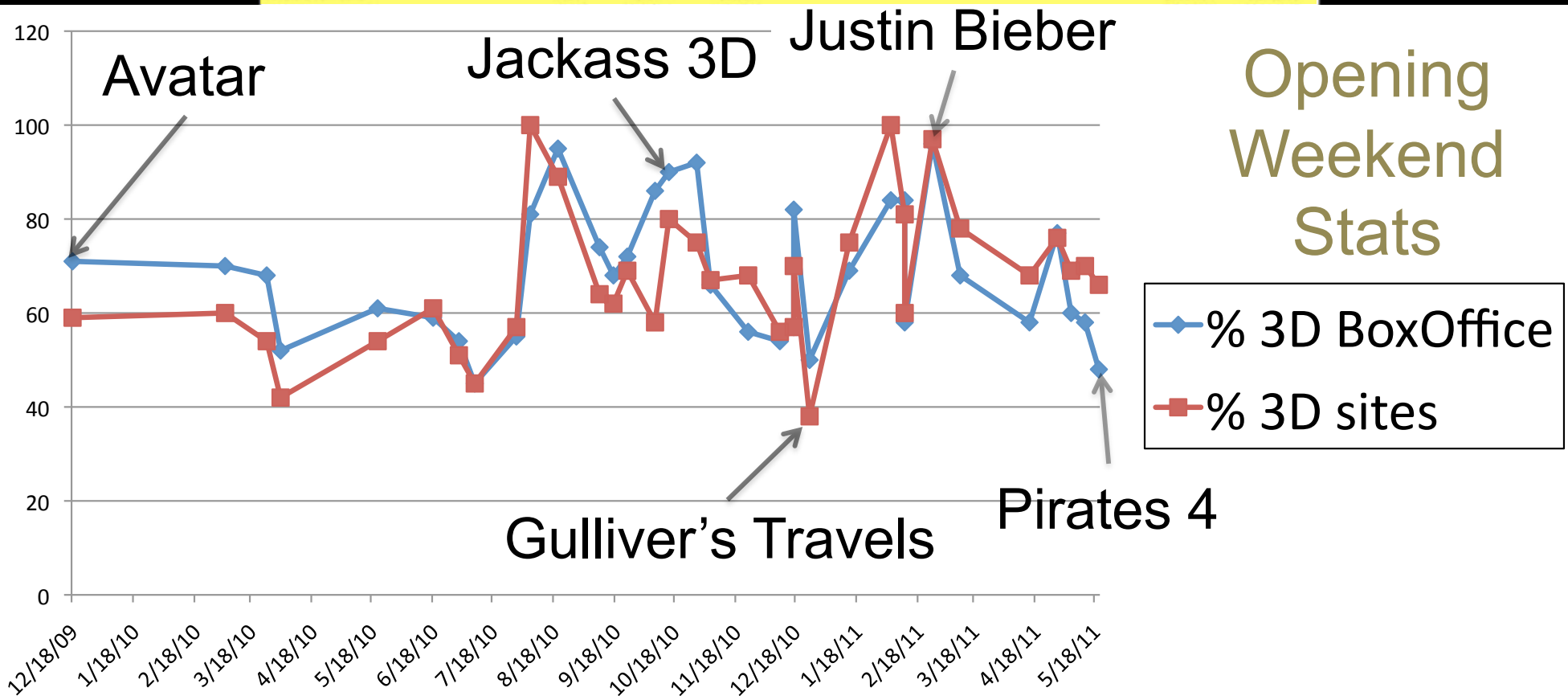
Title	Studio	Theaters	Opening	Opening 3D	3D %	3D Sites	% of Sites w/3D	Lifetime Gross	Release Date
Bot	Dis	2,846	\$24.30	\$10.31	42%	1,823	64%	\$14.40	11/27/2008
My Bloody Valentine 3D	Dis	2,846	\$24.30	\$10.96	45%	1,823	64%	\$14.40	11/27/2008
Colony	Dis	2,249	\$16.70	\$11.76	70%	1,575	70%	\$11.76	11/27/2008
Monsters Vs. Aliens	P/D/W	4,104	\$59.30	\$32.60	55%	1,755	38%	\$198.40	3/27/2009
Up	Dis	3,766	\$66.10	\$36.40	52%	1,534	41%	\$293.00	5/29/2009
Ice Age: Dawn of the Dinosaurs	Fox	4,099	\$41.70	\$22.94	55%	1,606	39%	\$196.60	7/1/2009
G-Force	Dis	3,697	\$31.70	\$17.75	56%	1,604	43%	\$119.40	7/24/2009
The Final Destination	WB (NL)	3,121	\$27.40	\$19.18	70%	1,678	54%	\$66.50	8/28/2009
Cloudy with a Chance of Meatballs	Sony	3,119	\$30.30	\$18.00	59%	1,828	59%	\$124.90	9/18/2009
A Christmas Carol (2009)	Dis	3,683	\$30.10	\$22.27	74%	2,045	56%	\$137.90	11/6/2009
Avatar	Fox	3,452	\$77.00	\$55.00	71%	2,038	59%	\$769.50	12/18/2009
Alice in Wonderland (2010)	Dis	3,728	\$116.10	\$81.00	70%	2,251	60%	\$334.20	3/5/2010
How to Train Your Dragon	P/D/W	4,055	\$43.70	\$29.70	68%	2,178	54%	\$217.60	3/26/2010
Clash of the Titans (2010)	WB	3,777	\$81.20	\$31.82	52%	1,602	42%	\$163.20	4/2/2010
Shrek Forever After	P/D/W	4,359	\$78.80	\$43.20	51%	2,373	54%	\$238.70	5/21/2010
Toy Story 3	Dis	4,028	\$110.30	\$65.40	59%	2,483	61%	\$415.00	6/18/2010
The Last Airbender	Par	3,169	\$40.30	\$21.76	54%	1,606	51%	\$131.80	7/1/2010
Despicable Me	Uni	3,476	\$56.40	\$25.38	45%	1,551	45%	\$251.50	7/9/2010
Cats & Dogs: The Revenge of Kitty	WB	3,705	\$12.30	\$6.77	55%	2,130	57%	\$43.60	7/30/2010
Step Up 3-D	Dis	2,435	\$15.80	\$12.80	81%	2,435	100%	\$42.40	8/6/2010
Piranha 3D	W/Dm	2,470	\$19.10	\$9.60	50%	2,200	89%	\$25.00	8/20/2010
Resident Evil: Afterlife	SGem	3,203	\$26.70	\$19.76	74%	2,062	64%	\$60.10	9/10/2010
Alpha and Omega	LGF	2,625	\$9.10	\$6.19	68%	1,625	62%	\$25.10	9/17/2010
Legend of the Guardians	WB	3,575	\$16.10	\$11.59	72%	2,479	69%	\$55.70	9/24/2010
My Soul to Take	Uni	2,572	\$6.80	\$5.85	86%	1,500	58%	\$14.79	10/8/2010
Jackass 3-D	Par	3,081	\$50.40	\$45.36	90%	2,452	80%	\$117.20	10/15/2010
Saw 3D	LGF	2,808	\$22.50	\$20.70	92%	2,106	75%	\$45.70	10/29/2010
Megamind	P/D/W	3,944	\$48.00	\$30.40	63%	2,634	67%	\$148.40	11/5/2010
Tangled	Dis	3,603	\$48.80	\$27.33	56%	2,461	68%	\$194.40	11/24/2010
Narnia: The Voyage of the Dawn	Fox	3,555	\$24.00	\$12.96	54%	1,999	56%	\$193.50	12/10/2010
Tron: Legacy	Dis	3,451	\$44.00	\$30.00	62%	2,424	70%	\$179.60	12/17/2010
Yogi Bear	WB	3,515	\$16.40	\$9.35	57%	2,011	57%	\$97.60	12/17/2010
Gulliver's Travels	Fox	2,546	\$6.30	\$3.15	50%	958	38%	\$42.80	12/25/2010
The Green Hornet	Sony	3,564	\$33.50	\$23.12	69%	2,794	75%	\$98.80	1/14/2011
Sandstorm	Uni	2,787	\$9.40	\$7.90	84%	2,787	100%	\$23.20	2/4/2011
Gnomes and Juliet	Dis	2,994	\$25.40	\$14.73	58%	1,809	60%	\$97.80	2/11/2011
Justin Bieber: Never Say Never	Par	3,105	\$29.50	\$24.76	84%	2,516	81%	\$72.80	2/11/2011
Drive Angry	Sum	2,290	\$5.20	\$4.99	96%	2,223	97%	\$10.79	2/25/2011
Mars Needs Moms	Dis	3,117	\$5.20	\$3.54	68%	2,440	78%	\$20.90	3/11/2011
Rio*	Fox	3,826	\$39.20	\$22.74	58%	2,591	68%	\$131.60	4/15/2011
Hoodwinked Too!	Wein	2,505	\$4.10	\$3.16	77%	1,900	76%	\$9.20	4/29/2011
Thor*	Dis	3,955	\$68.00	\$39.60	60%	2,737	69%	\$145.00	5/6/2011
Priest *	Sony	2,864	\$15.00	\$9.60	64%	2,006	70%	\$23.79	5/13/2011
Pirates of the Caribbean *	Dis	4,155	\$90.10	\$31.68	35%	2,747	66%	\$90.10	5/20/2011

\* Still in Release

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Source: Box Office Mojo and BTIG Research Estimates

# Are audiences tiring of 3d?



Pirates of the Caribbean *	DIS	4,155	\$90.10	\$36.65	40%	2,747	66%	\$90.99	5/20/2011
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\* Still in Release

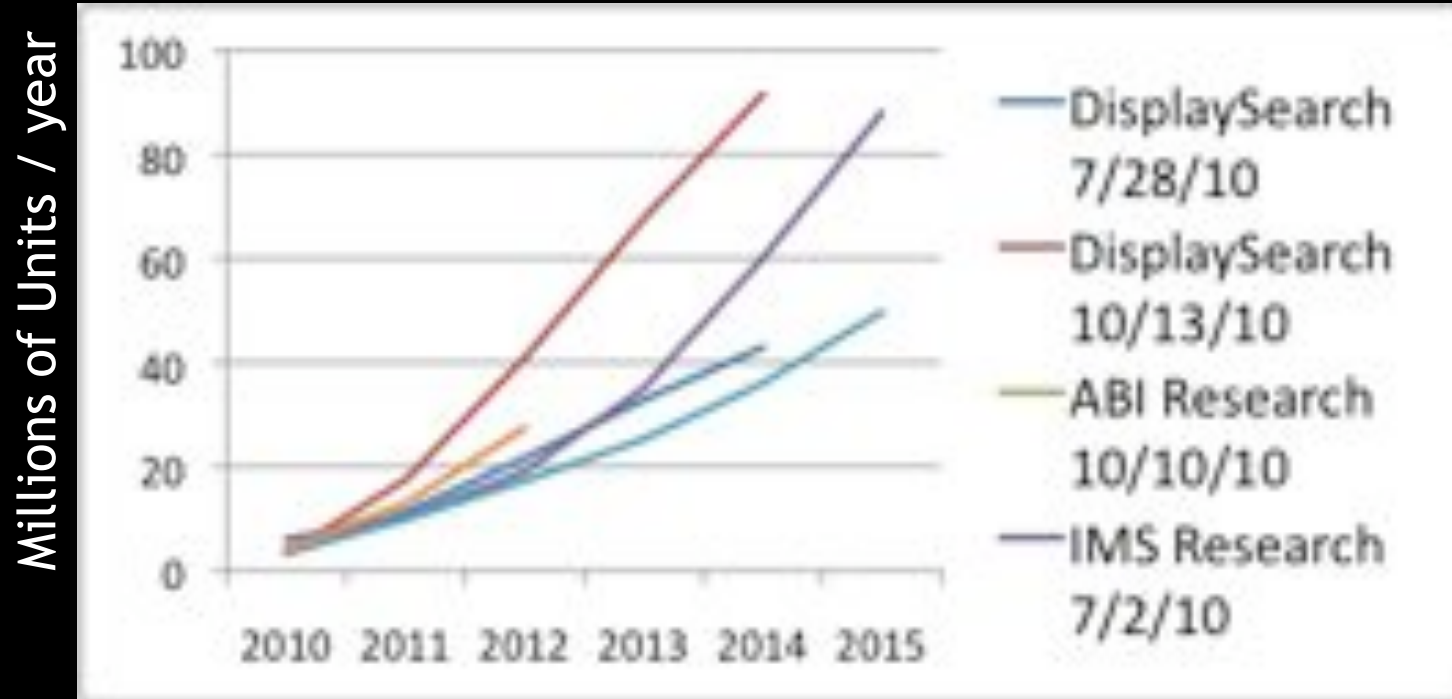
Source: Box Office Mojo and BTIG Research Estimates

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1. 3D Content Creation
2. 3D in Movie Theatres
3. 3D TVs
4. 3D on Smaller Devices
5. What's Coming
6. Research Areas of Interest

# Worldwide 3D TV Forecast



3.2M to 6.2M 3D TVs sold in 2010

50M to 88M 3D TVs sold in 2015

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# Worldwide 3D TV Forecast



## TV Makers get bad reception for 3D

Source: Wall Street Journal

December 19, 2010

**Tagged to move** | Prices of 3-D TVs are falling to spur demand

	SHARP	Panasonic	SAMSUNG	LG	SONY	TOSHIBA
Model:	60-inch Aquos Quattron 3-D TV	65-inch Viera plasma 3-D TV	65-inch 8000-series 3-D LED TV	55-inch Infiniti 3-D LED TV	60-inch Bravia NX900 3-D TV	55-inch 3-D LED TV
Suggested retail price:	\$5,299	\$4,299	\$5,999	\$5,400	\$4,699	\$3,299
Lowest price on Bing.com:	\$3,095	\$3,619	\$3,390	\$2,291	\$3,395	\$1,579
Difference in price:	42%	16%	43%	58%	28%	52%

Ref: These models were released in 2010. Source: WSJ.com/Bing

# Polarized 3D TVs coming to consumer market

- Re-energize the market? -

LG  
Vizio  
Samsung  
others

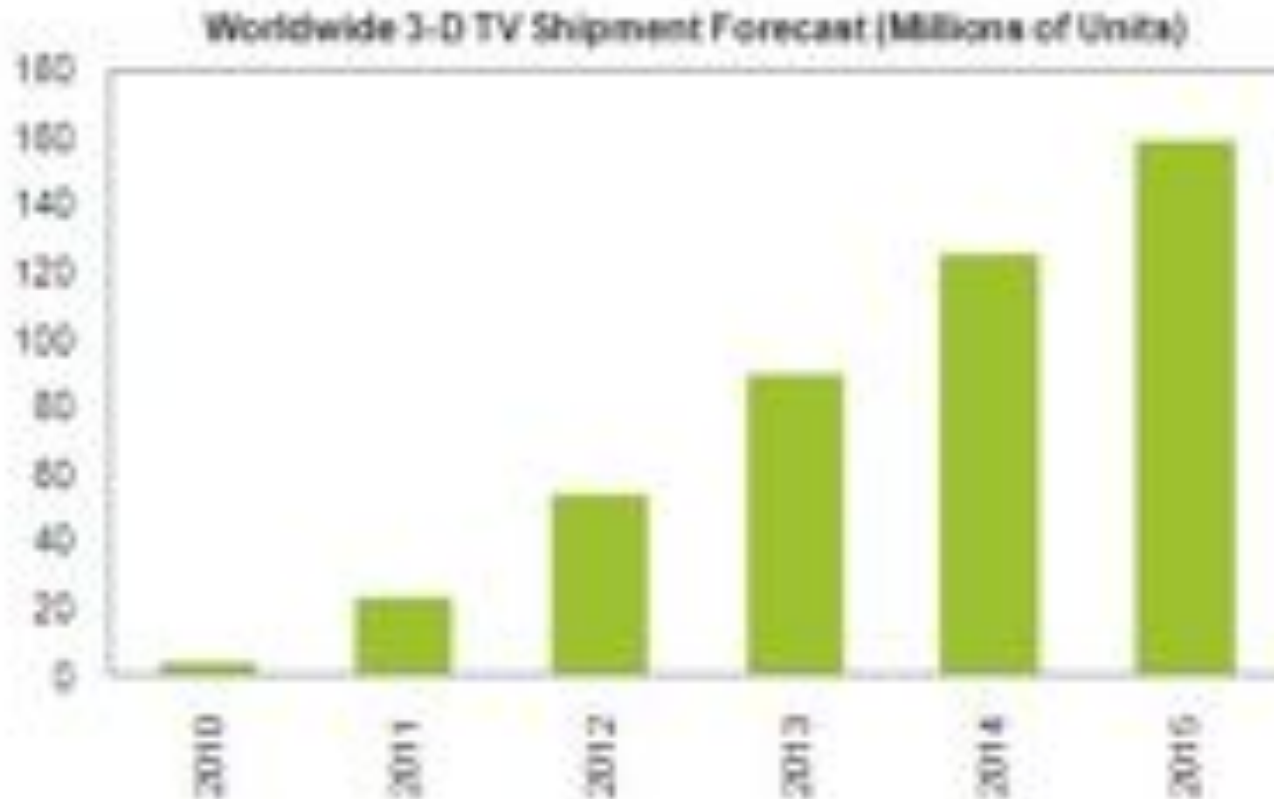


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# Worldwide 3D TV Forecast

Millions of Units / year



Source: IHS iSuppli Research, May 2011

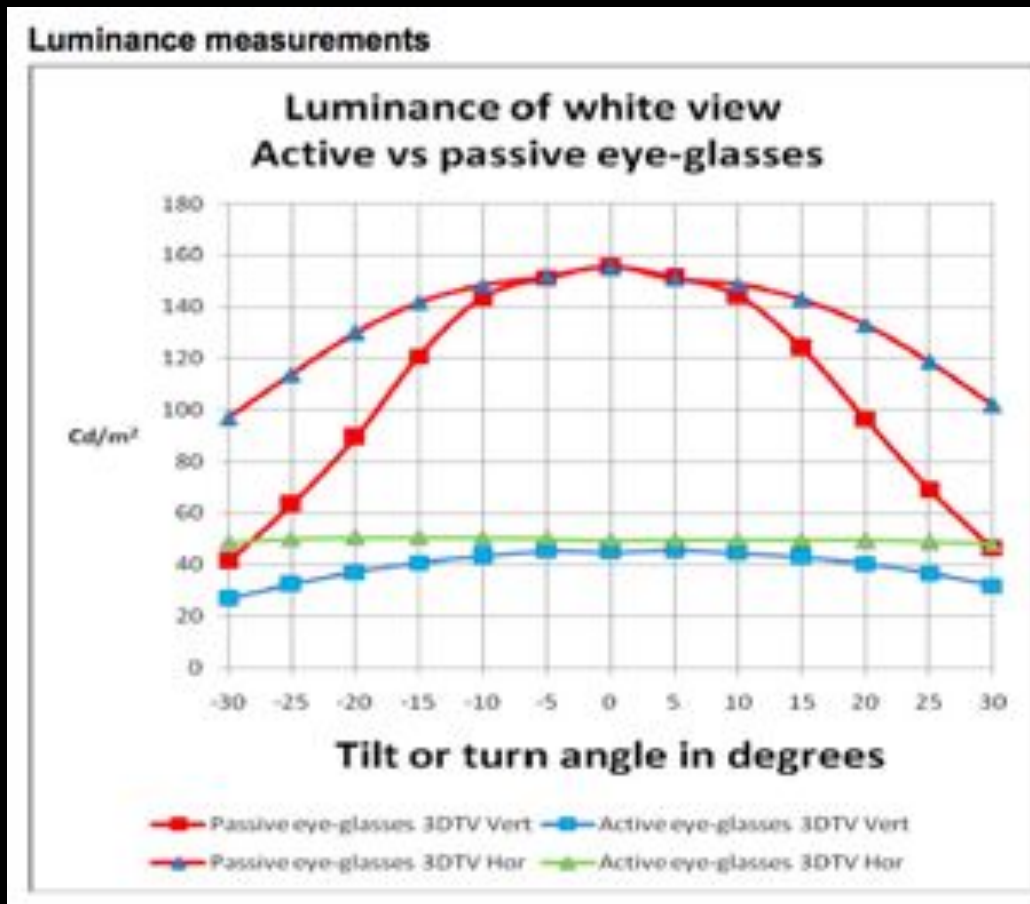
More  
Optimistic

5/6/11

# Active vs Passive\*

Not a  
format war

- consumer  
choice -



Much more  
technical and  
consumer  
research  
needed

\*Source: TCO Development 3DTV Study, 4/28/11, Philip Lelyveld – Philip@PhilipLelyveld.com

# 3D Glasses landscape

## Active models



Sony \$110



Samsung \$150



Panasonic  
\$80



Logitech



XPAND \$130



Viewsonic \$90



NGX \$55



nVidia \$95

No tint or performance standards

## Passive models



LG \$11  
Clip-on



Ingri:Dahl  
\$29.50



RealD \$3



MicroVision  
\$32.50



Sfirex \$110  
prescription

# Large Autostereoscopic Displays

## A work in progress



### Dimenco 52" screen

- “new approach”
- targeting **business** customers
- consumer price in a few years
- \$8,000

# Autostereoscopic Displays

## State of the Art and the Way Forward

By Gregg Favalora of Optics for Hire

**Agenda**

- **Fundamentals**
  - Define autostereoscopic
  - Goals / quantify the challenge
  - Enabling technologies
  - Lens-oblivious depth cues
  - Window Violations
- **Display-Type & Recent Examples**
  - Specialty multiplexed display
    - Parallax-barrier displays
    - Integral photography
    - Lenticular displays
  - Specular display
    - Multi-projector
    - Fourier-plane
    - Vibrating lenticular
    - Directional backlighting
- **(Continued)**
  - Volumetric Displays
  - Holographic / Quasi-holo
  - Hot Topics
  - Wrap-up / resources

Thank you for attending! Contact: Greg Favalora, Optics for Hire, 1000 1st Ave, Suite 100, New York, NY 10022, USA. Email: greg@opticsforhire.com

(Source: SMPTE 4/28/11 podcast, available at [http://www.smpte.org/education/SMPTE\\_PDA\\_On-demand/](http://www.smpte.org/education/SMPTE_PDA_On-demand/))  
Philip Lelyveld – [Philip@PhilipLelyveld.com](mailto:Philip@PhilipLelyveld.com)

"There are no best products, only best perceptions".

Prof Jankel

Dean of Bath Business School (UK)



Pleasant **buying** experience comes before  
a pleasant **viewing** experience

Consumers don't buy technology,  
they buy the **experiences** that  
technology delivers





# Market Research

## - 3D TV Owners -

Study date: 3/1-31/11  
Sample size: 3,056  
Profile: US 3D TV owners

88% liked the 3D image quality  
91% liked the HD image quality

Preferred content types  
78% movies  
77% animation  
75% nature  
67% football

85% would like half to all  
content to be in 3D

28% own Playstation 3  
76% of them play 3D games

# Consumer Market

## 3 Legs of the Stool



Australia  
Germany  
Belgium  
Brazil  
Estonia  
Turkey  
Korea  
Japan  
UK  
US  
...

# 3D Content

## 3D Channels

3D  
Games

			Q1'10	Q2	Q3	Q4	Q1'11
Japan	Cable	JCOM					
	Satellite	BS11					
		SkyPerfect JSAT					
	IPTV	Hikari					
Korea	Cable	CJ					
	Satellite	SkyLife					
	IPTV	SK Telecom					
Australia	Satellite	Foxtel					
USA	Cable	Comcast					
		Cablevision					
	Satellite	DirectTV					
		Dish				tentative	
	IPTV	AT&T U-Verse					
		Verizon FIOS					
France	Cable	Numericable					
	Satellite	Canal+					
	IPTV	Orange					
Germany	Satellite	Sky.de					
	IPTV	Telekom					
Italy	Satellite	RAI					
Netherlands	Cable	UPC					
Spain	Satellite	Canal+					
	IPTV	Telefonica					
UK	Cable	Virgin Media					
	Satellite	Sky					
Czech Republic	Satellite	IKO TV					
Poland	Satellite	Cyfrowy+					
Russia	Cable	Akado					
	Satellite	NTV plus					
Slovakia	Satellite	IKO TV					
United Arab Emirates	Satellite	Du					

3D Blu-ray

# Impact of display size on 3D authoring

**Looking at the horizon** = eye spacing  
interocular distance  
2.5"

## **40' theater screen**

"2K" projector = 1920 pixels across  
 $(1920 \text{ pixels} / 480") \times 2.5" = \mathbf{10 \text{ pixels}}$

## **60" 3D TV**

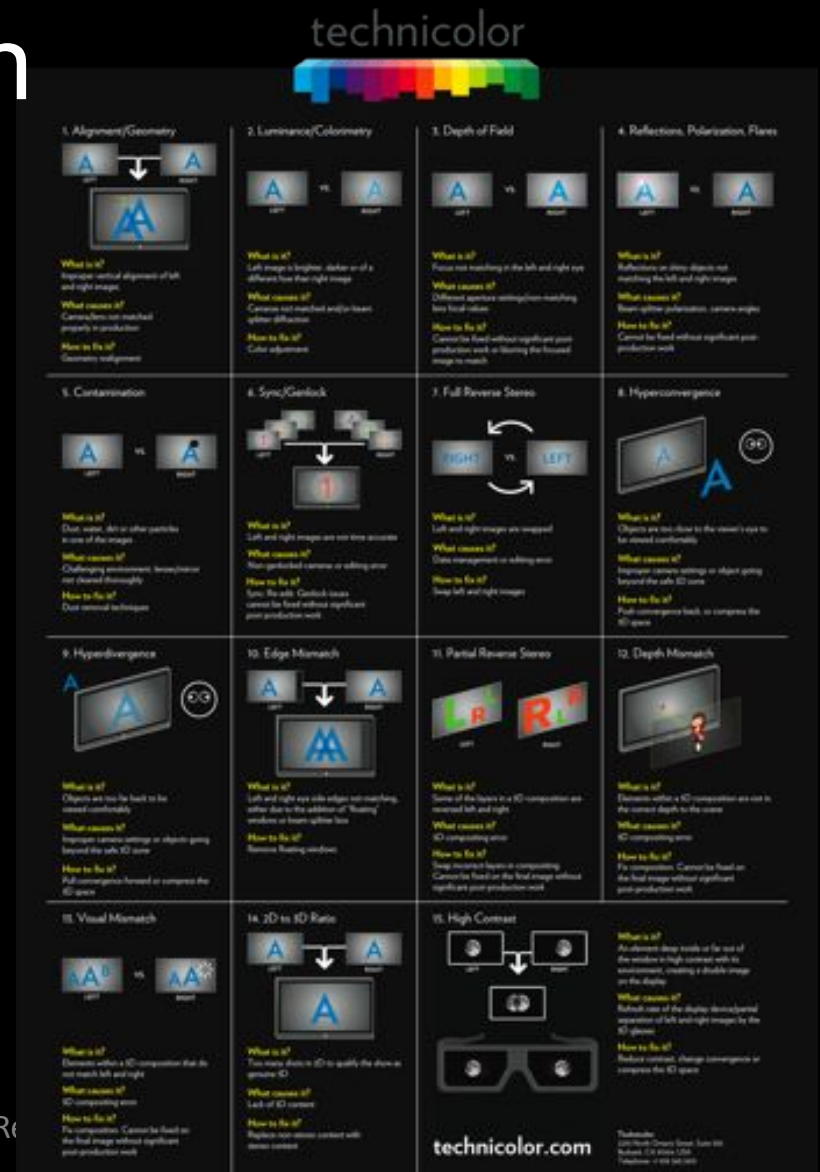
$(1920 \text{ pixels} / 60") \times 2.5" = \mathbf{80 \text{ pixels}}$

• Encoding algorithms  
• Games

# Technicolor Certification

1. Alignment / Geometry
2. Luminance / Colorimetry
3. Depth of Field
4. Reflection / Polarization / Flares
5. Contamination
6. Sync / Gen Lock
7. Full Reverse Stereo
8. Hyperconvergence
9. Hyperdivergence
10. Edge Mismatch
11. Partial Reverse Stereo
12. Depth Mismatch
13. Visual Mismatch
14. 2D to 3D Ratio
15. High Contrast

Philip Lelyveld – Phil@R



# THX 3D certification ecosystem

THX's Rick Dean will discuss

THX Certified Displays program



THX partners with BluFocus, an official Blu-ray Disc Assoc test center



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Playing  
+ sharing  
with others!  
Glasses-free  
3D!

Netflix  
Short films!

Nintendo 3DS  
first personal 3D



\$249 MSRP

Augmented  
Reality  
Games

3D Camera!

Many 3D Games!

Playing  
+ sharing  
with others!

Nintendo 3DS  
first personal 3D

Augmented  
Reality  
Games



3D

Glasses-free  
3D!

3DS Autostereo screen



Kids, teens, early twenties



Adults

Netflix  
Short films!

# Trends in **Mobile** 3D devices

Three key applications:

- **creation and sharing** of user-generated 3D content
- **playback** of 3D content
- 3D **gaming**

(Source, ABI Research, 4/20/11)

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# Autostereo 3D Phones



LG Optimus 3D  
Dual 5 Megapixel  
cameras



HTC EVO 3D  
Dual 5 Megapixel  
cameras



Sharp Aquos SH-12C  
Dual 8 Megapixel  
cameras

# Consumer 3D Cameras

Sony Bloggie 3D  
1080P video (4 hrs)  
5 Megapixel (x2) pictures  
Autostereo display  
\$249 msrp



GoPro 3D Hero System  
Two 1080P cameras  
plus mount  
\$620 and up msrp

FujiFilm FinePix 3D  
3D video (multi formats)  
10 Megapixel pictures  
Autostereo display  
\$395 and up msrp





# Advances in autostereo



Toshiba laptop runs 3D in one window, 2D in another!  
- uses face tracking and 'active lenses'  
(4/20/11, Toshiba dynabook Qosmio T851/D8CR notebook, due July, 2011)

Consumers don't buy technology,  
they buy the **experiences** that  
technology delivers



# Nintendo 3DS Games

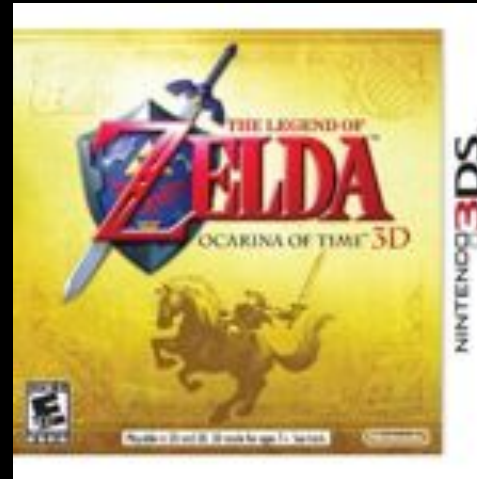


Nintendogs +  
cats 3D



Resident Evil:  
The Mercenaries  
3D

The Legend of  
Zelda: Ocarina  
of Time 3D



Super Street  
Fighter IV: 3D  
Edition

~\$40 each

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# 3D In Theatres

## Tech Waiting in the Wings

Faster frame rates

3D Audio

Brighter lamphouses

4D Theaters

2-Way Communication

# Dome theatres

US	382 domes*
Int'l	445 domes*



Vortex Immersion Media and others  
experimenting with 3D dome experiences

\* # permanent dome structures - Source: [www.lochnessproductions.com](http://www.lochnessproductions.com)

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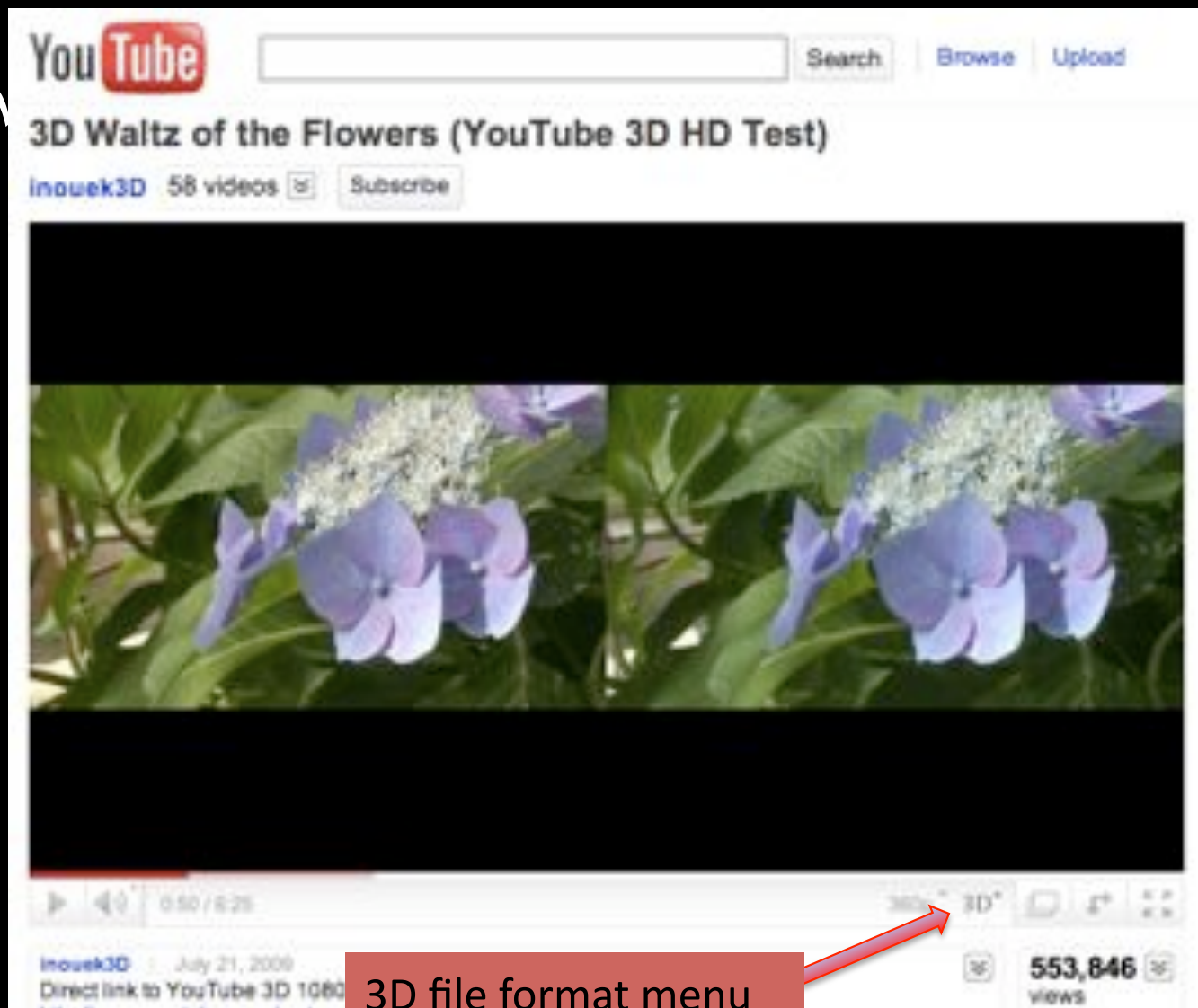
# 3D autostereo Augmented Reality



## LG Thrill 3D 4G phone

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DYI (“Do It Yourself”)  
S3D community  
A pipeline for  
more content



# Tribeca Flashpoint Media Arts Academy

## 10<sup>th</sup> Annual Tribeca Film Festival



“**LG's sponsorship** has proven to be invaluable for these **budding young film-makers** to experiment and hone their 3D skills.”

## "Your Life in Sony 3D"

Consumer competition – submit **ideas**

- Sports & Recreation
- Arts & Entertainment
- Cause & Community
- Life Milestones & Events

Grand prize: **a 3D video** of the winning idea

- shot on Sony professional equipment and
- **aired nationally** on 3net, the 24/7 3D network

# Agenda

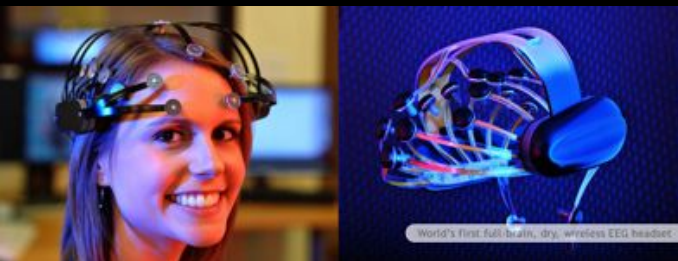
1. 3D Content Creation
2. 3D in Movie Theatres
3. 3D TVs
4. 3D on Smaller Devices
5. What's Coming
6. **Research Areas of Interest**

# Research Areas of Interest

Not currently a direct ETC activity

## Art of 3D Storytelling

- Eye tracking studies: what influences where you look
- Impact of 3D vs 2D vs Ultra High Def vs ...
- Interaction between 3D video and 3D audio
- Role of 3D within broader entertainment experience



NeuroFocus / Nielsen

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# Research Areas of Interest

Not currently a direct ETC activity

## Technology of 3D

- Capture technology
- Projection technology
- Autostereoscopy
- Virtual production integrated with live action
- Metadata management
- Consumer tools

# Research Areas of Interest

Not currently a direct ETC activity

## 3D Marketplace

- Advertising and digital signage
- Usage attributes in different situations
- Changes in features and genre demand over time

# Research Areas of Interest

Not currently a direct ETC activity

## Vision Science

- Basic stereoscopic norms for the general population
  - What metrics matter
  - Impact of 3D viewing on children
- Psycho-physiological effects of 3D
  - Impact of 2D-3D conversion or blending
  - **Impact of frame rate, shutter behavior, other motion factors**
  - Pixel resolution, color depth, other static factors
- Changes in the 3D experience over time

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# Research Areas of Interest

Not currently a direct ETC activity

## 3D in Education, Training, and other markets

- Best practices for integrating 3D into the process
- Impact on learning and retention
  - 2D / 3D double blind tests

Consumers don't buy technology,  
they buy the **experiences** that  
technology delivers



# Conclusion

3D will be in TVs, PCs, game consoles, etc.,  
as well as movie theatres

We are starting to see how consumers want  
to experience 3D outside of the theatre

All sorts of product/service development  
and entrepreneurial opportunities exist



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# Thank You

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