



thrive
SIGGRAPH2019
LOS ANGELES 28 JULY - 1 AUGUST

Capture4VR

From VR Photography to VR Video

richardt.name/Capture4VR

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Who are we?

Christian Richardt

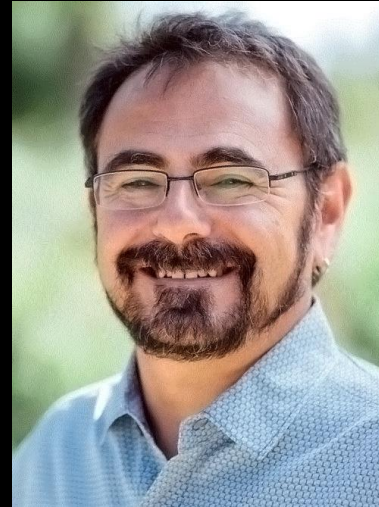
Peter Hedman

Ryan S. Overbeck

Brian Cabral

Robert Konrad

Steve Sullivan



Virtual reality

- Offers unparalleled immersion
- Still a young medium
- We need new ways:
 - to author content
 - to capture from the real world
- In this course, we:
 - provide an overview of progress in VR photography and VR video
 - discuss state-of-the-art systems by Facebook, Google + Microsoft



Course schedule

Start	Topic	Speaker
14:00	1. Introduction	Christian Richardt, Bath
14:20	2. 360° (Stereo) Panoramas	Christian Richardt, Bath
14:40	3. 3D Photography	Peter Hedman, UCL
15:00	4. Light Field Photography	Ryan S. Overbeck
15:20	Q&A + <i>Break</i>	
15:35	5. 360 and ODS Video	Brian Cabral, Facebook
15:55	6. Live ODS Video	Robert Konrad, Stanford
16:15	7. 6-DoF Video	Brian Cabral, Facebook
16:35	8. MR Capture Studios	Steve Sullivan, Microsoft
16:55	9. Conclusion + Q&A	All presenters

1. Introduction

Christian Richardt

- Welcome + introduction of co-presenters
- Overview and structure of this course
- A brief history of panoramas and stereoscopy



2. 360° (Stereo) Panoramas

- Traditional panorama stitching
 - applications in consumer devices
- Omnidirectional stereo (ODS) panoramas
 - Omnistereos
 - Megastereos
- Panoramas with motion parallax
 - Parallax360
 - MegaParallax

Christian Richardt



3. 3D Photography

Peter Hedman

- VR photography with textured 3D reconstructions from hand-held photos:
 - Casual 3D photography
 - Instant 3D Photography
- More immersive exploration in VR:
 - enables full 6 degrees-of-freedom (6-DoF) head motion
 - allows users to look around freely in VR



4. Light field photography

- Introduction to light fields
- Google's panoramic light fields:
 - capturing ~1000 photos of a scene
 - process using structure-from-motion and multi-view stereo
 - real-time rendering for VR HMDs
- Extensions to light field video
- DeepView:
 - view synthesis with multi-plane images

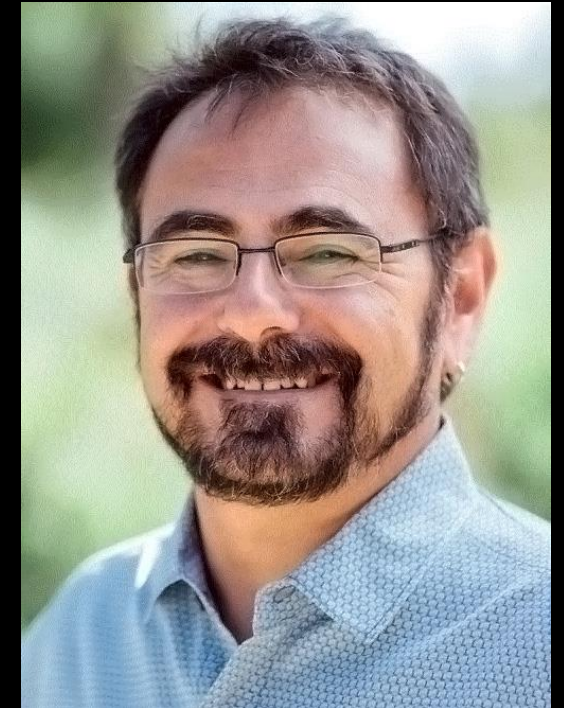
Ryan S. Overbeck



5. 360 and ODS video

- Moving from still images to moving pictures
- 360° video
 - affordable consumer 360° cameras
 - but lacks depth
- Omnidirectional stereo (ODS)
 - produces stereoscopic 360° video
 - but requires multi-camera rigs
 - e.g. Facebook Surround 360 or Google Jump

Brian Cabral



facebook

6. Live ODS video

- ODS video approaches usually require expensive off-line processing
 - prevents live streaming
- Overview of live streaming ODS:
 - live streaming ODS camera arrays
 - single-shot ODS systems
 - rotating systems for ODS capture

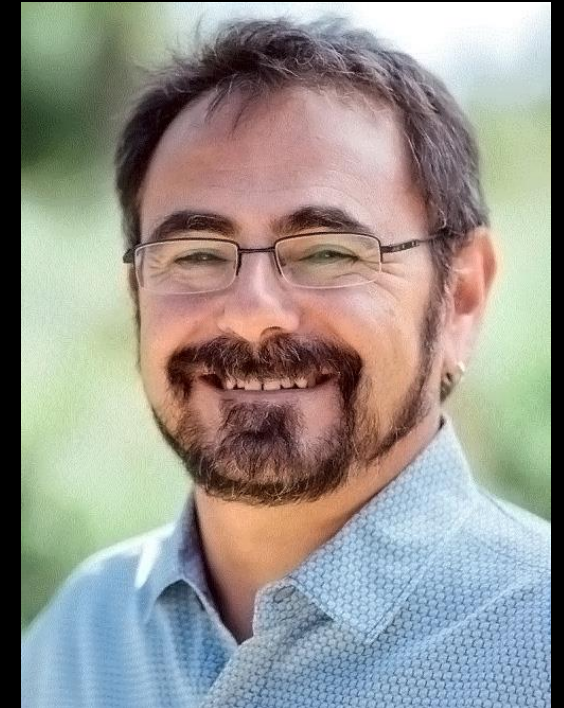
Robert Konrad



7. 6-DoF video

- Need support for 6-DoF motion within VR video
 - so that viewers can move their head around freely to explore a scene
- Facebook's latest camera rigs and techniques:
 - x6, x24 and Manifold cameras
 - 6-DoF video techniques and results

Brian Cabral



facebook

8. Microsoft Mixed Reality Capture Studios

- We also want to capture objects realistically
 - e.g. people and animals
- Volumetric video capture using outside-in camera arrangement
- Microsoft Mixed Reality Capture Studios:
 - state-of-the-art commercial facilities
 - overview of underlying technology
 - 'holograms' can be inserted into VR/AR experiences

Steve Sullivan



9. Conclusion + Q&A

Christian Richardt

- Short summary
- Discussion of remaining challenges towards ubiquitous 6-DoF VR photography and video
- Questions & answers



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Christian Richardt

A Brief History of VR Photography + Video



CAMERA

Centre for the Analysis of Motion,
Entertainment Research and Applications



UNIVERSITY OF
BATH

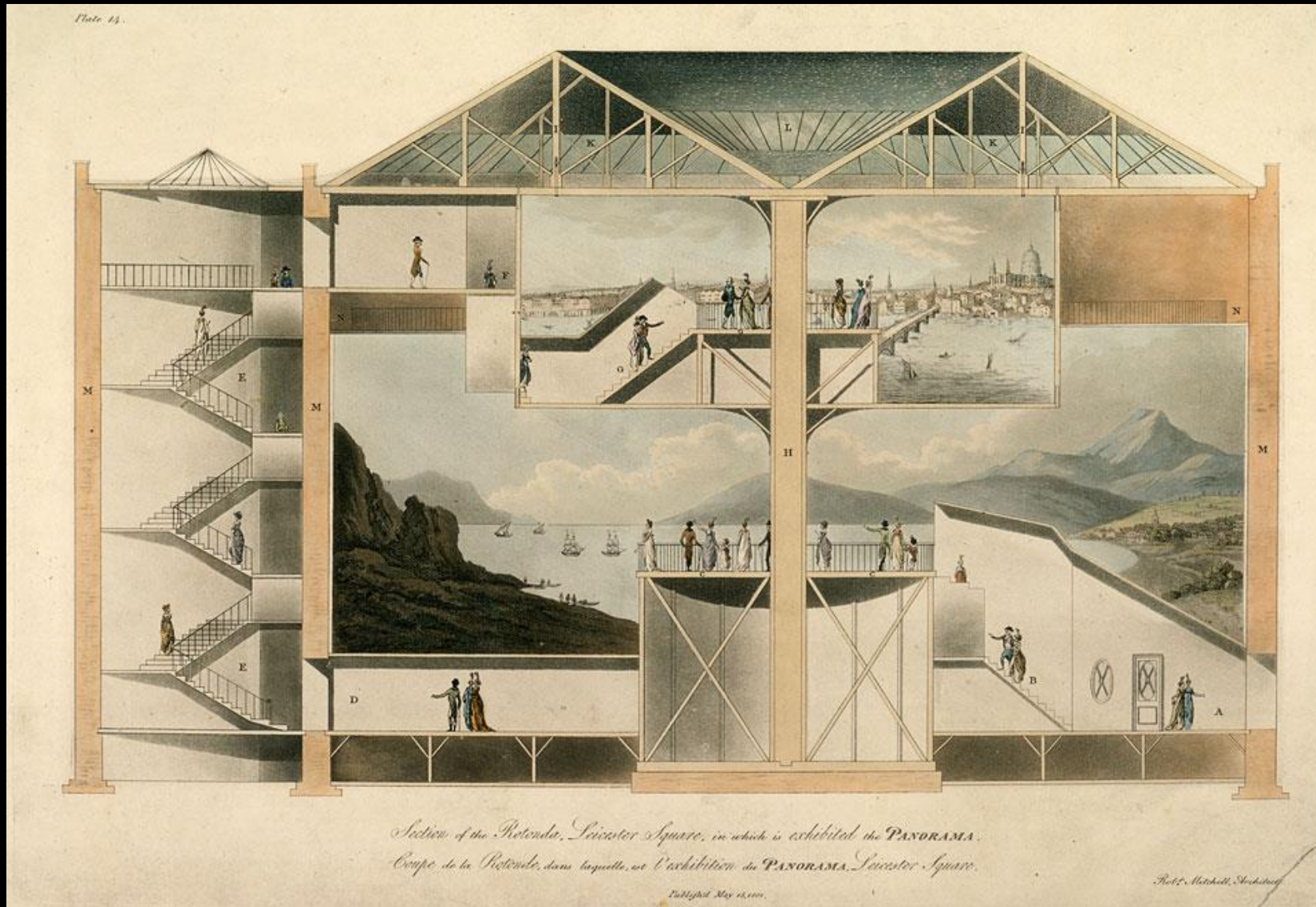
Panorama

- formed from Greek πᾶν "all" + ὄραμα "sight"
- term coined by painter Robert Barker in 1792
- definition: any wide-angle view or representation of a physical space



Panoramic view of London, from the top of Albion Mills, by Robert Barker, 1792

The Rotunda in Leicester Square (1793–1863)



Robert Mitchell, 1901

Panorama Mesdag (1881)



120 × 14 metres — painted in 1880–1881 by Hendrik Willem Mesdag

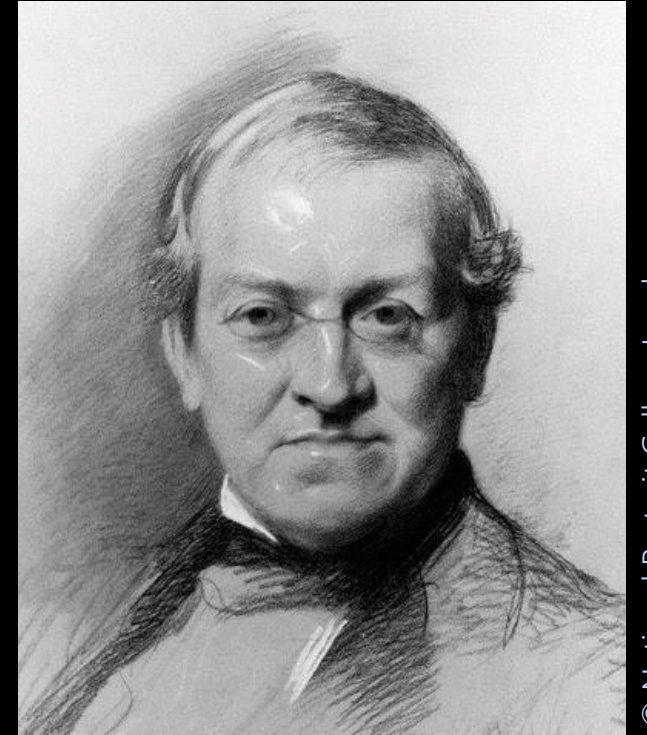
Gettysburg Cyclorama (1883)



115 × 13 metres — painted in 1882–1883 by Paul Philippoteaux

Stereoscopy

- Technique for creating or enhancing the illusion of depth in an image by means of stereopsis for binocular vision
- from Greek:
 - στερεός (stereos) — 'firm, solid'
 - σκοπέω (skopeō) — 'to look, to see'



© National Portrait Gallery, London

Charles Wheatstone
(1802–1875)

Wheatstone stereoscope (1838)

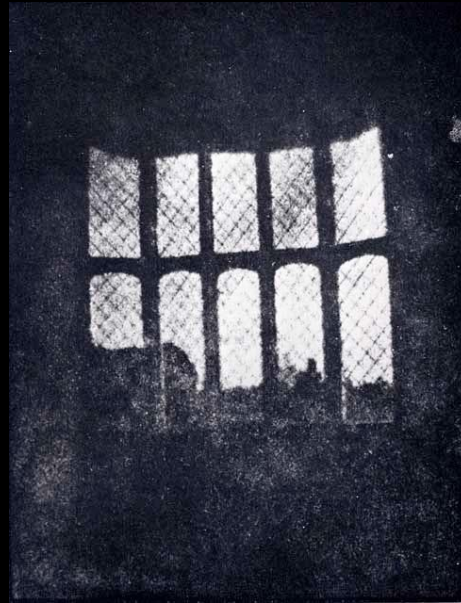


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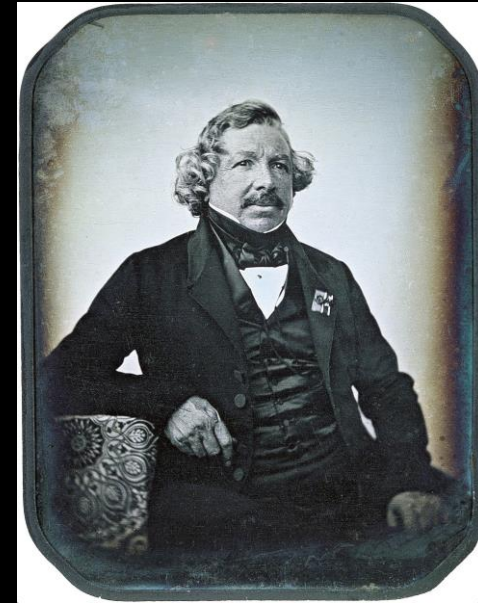
A brief history of photography



1826
First photograph
(Nicéphore Niépce)



1835
First negative
(Henry Fox Talbot)



1839
Daguerrotype
(Louis Daguerre)

Wheatstone stereoscope (1838)



© David Tett/King's College London

Brewster stereoscope (1849)



© The Bill Douglas Cinema Museum, University of Exeter



David Brewster
(1781–1868)

Holmes stereoscope (1861)



© Berezin Stereo Photography Products



Oliver Wendell Holmes
(1809–1894)

Holmes stereoscope (1861)



© publichistorymuse.wordpress.com

Stereo photography = Stereography



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New York, London, Paris, Chicago, Ottawa, Kansas



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Orington, N. J.
Linton, N. H.
Washington, D. C.
Studios

Victoria, Queen and Empress from 1837 to 1901 - England's most beloved and longest reigning Sovereign.
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Chicago's Court of the District Court of the U.S. for Southern District of New York.

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East River Bridge, N. Y.
Harbor, U. S. A.

1150 - Trocadero Entrance to the Exposition, Colonial Section in Foreground, Paris, 1900.

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875 - A Mighty Monument to Pagan Brutality - the Colosseum (E.), Rome, Italy.

1302 - The Taj Mahal, Agra, India.

Copyright 1906, by W. S. Smith.

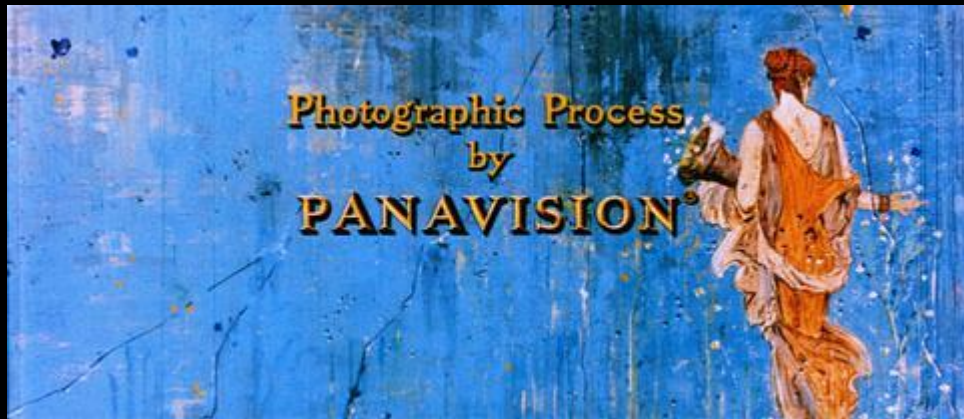
Motion Pictures (1890s)



The U.S. National Archives (1926)

Widescreen motion picture film formats

- First success in late 1920s and before 1932 Great Depression:
 - e.g. NaturalVision, Fox Grandeur, Magnifilm (2:1 aspect ratio)
 - Warner Vitascope, MGM Realife
- Second wave in 1950s and 60s:
 - Ultra Panavision 70 (2.76:1)
 - Ben-Hur (1959)
 - CinemaScope (2.35:1 – 2.55:1)
 - Lady and the Tramp (1955)
 - Super Panavision 70 (2.20:1)
 - 2001: A Space Odyssey (1968)



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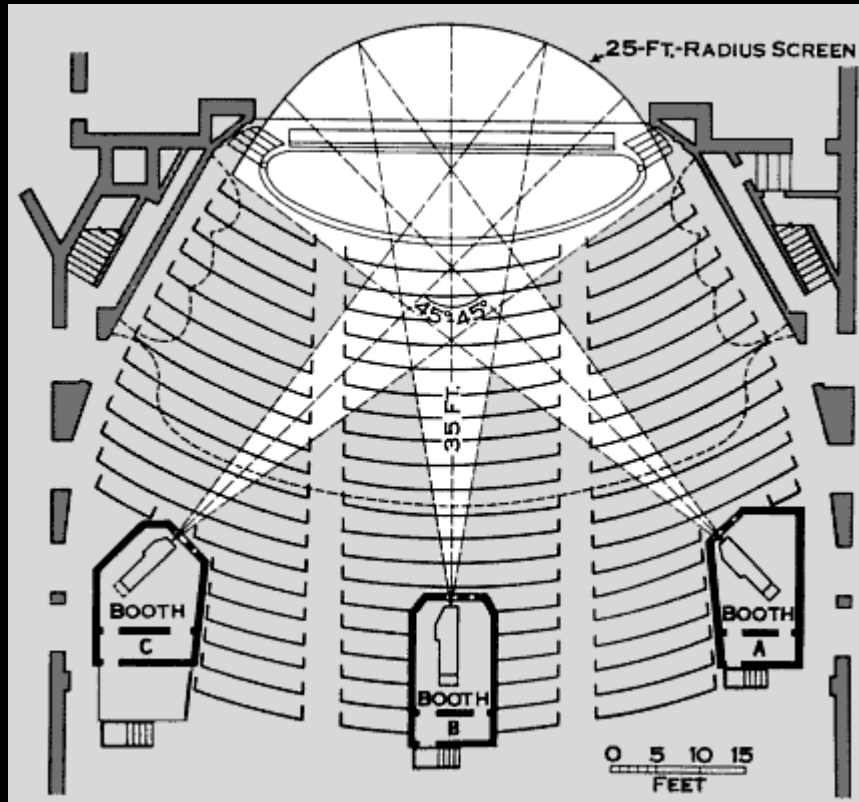
Screenshot of "The Big Fisherman" (1959), the first film released using the Super Panavision 70 process.



Multi-projector projection

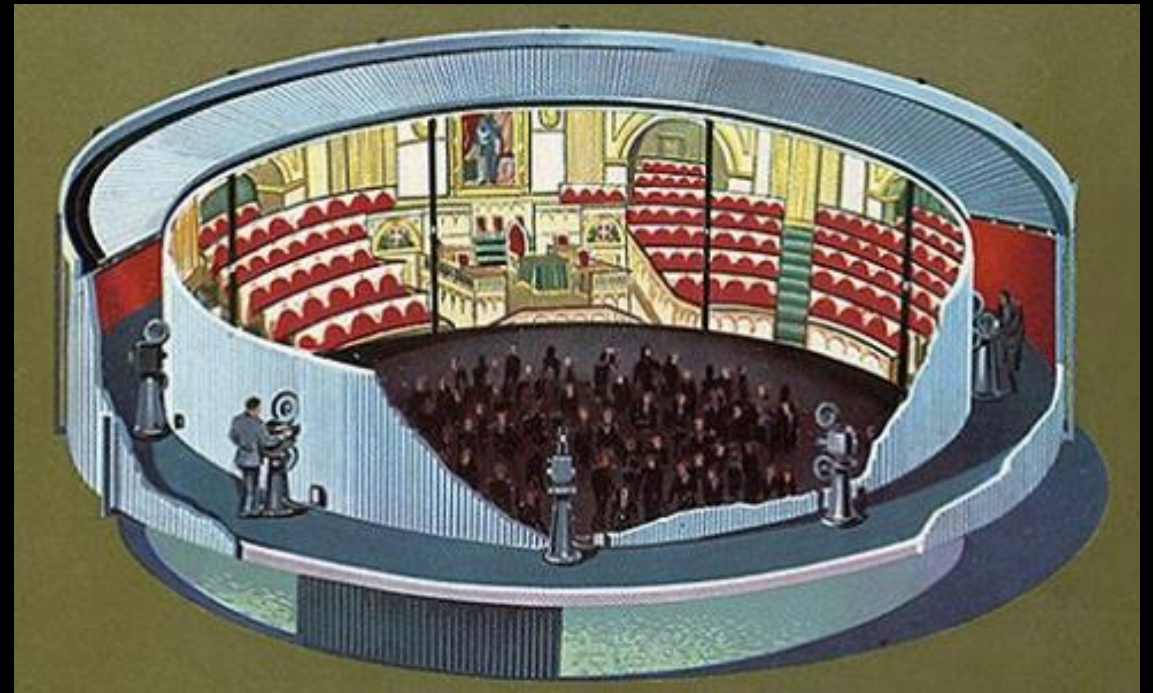
Cinerama (1952)

3 × 35mm projectors



Circle-Vision 360° (1955)

9 × 35mm projectors



<https://www.themeparktourist.com/>