Virtual Reality

Visual Imaging in the Electronic Age

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November 12, 2020

lecture #20

Immersion

Zurich University of the Arts

What is Virtual Reality?

Virtual Reality

- A term used to describe a computer generated environment which can simulate the perception of PRESENCE.

Virtual Reality

- A person immersed within this virtual world can manipulate objects, interact with the environment, and explore the virtual world in the same perceptual way as one interacts with the physical world.

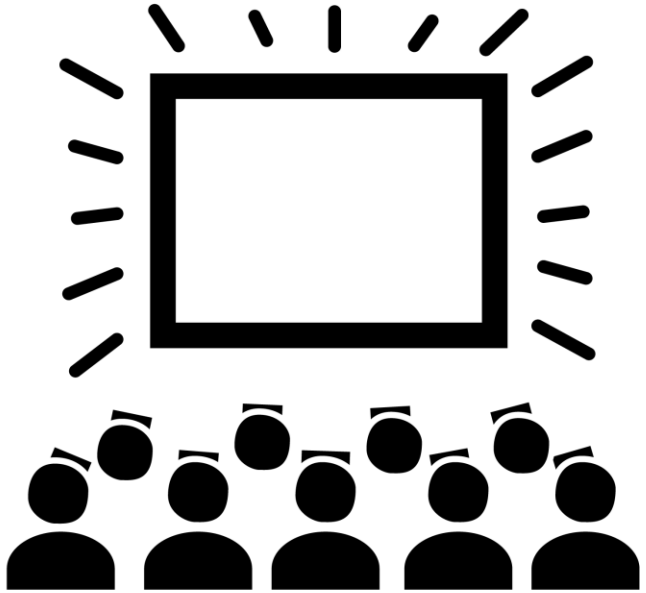
More than for Gamers

- Military
- Sport
- Mental Health
- Medical Training
- Education
- Design
- Entertainment
- Communication

Alayna Mansell

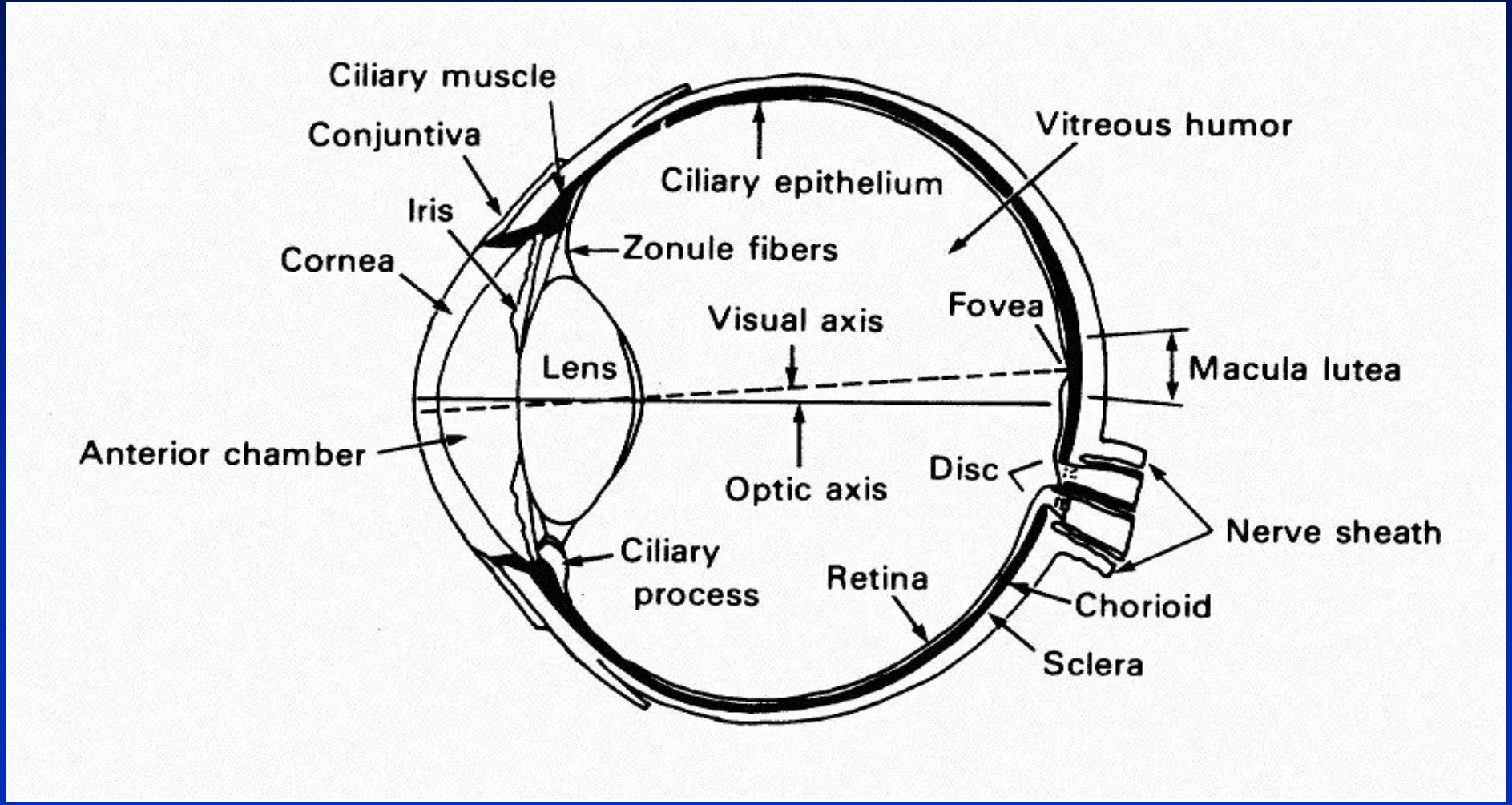
The Human in the Loop

- Abstract Interpretation
- Viewing a Picture on Television
- Cinema Viewing
- Presence

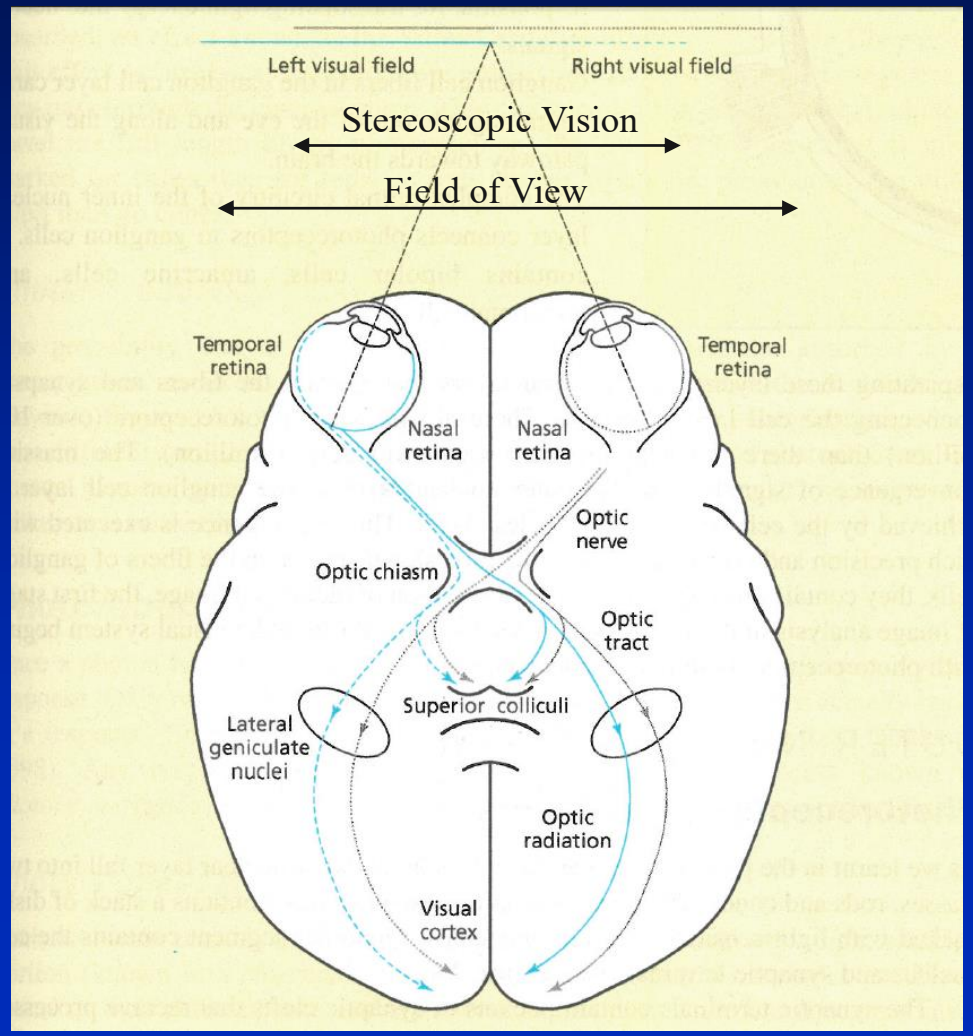


Review

Cross Section of Eye & Retina



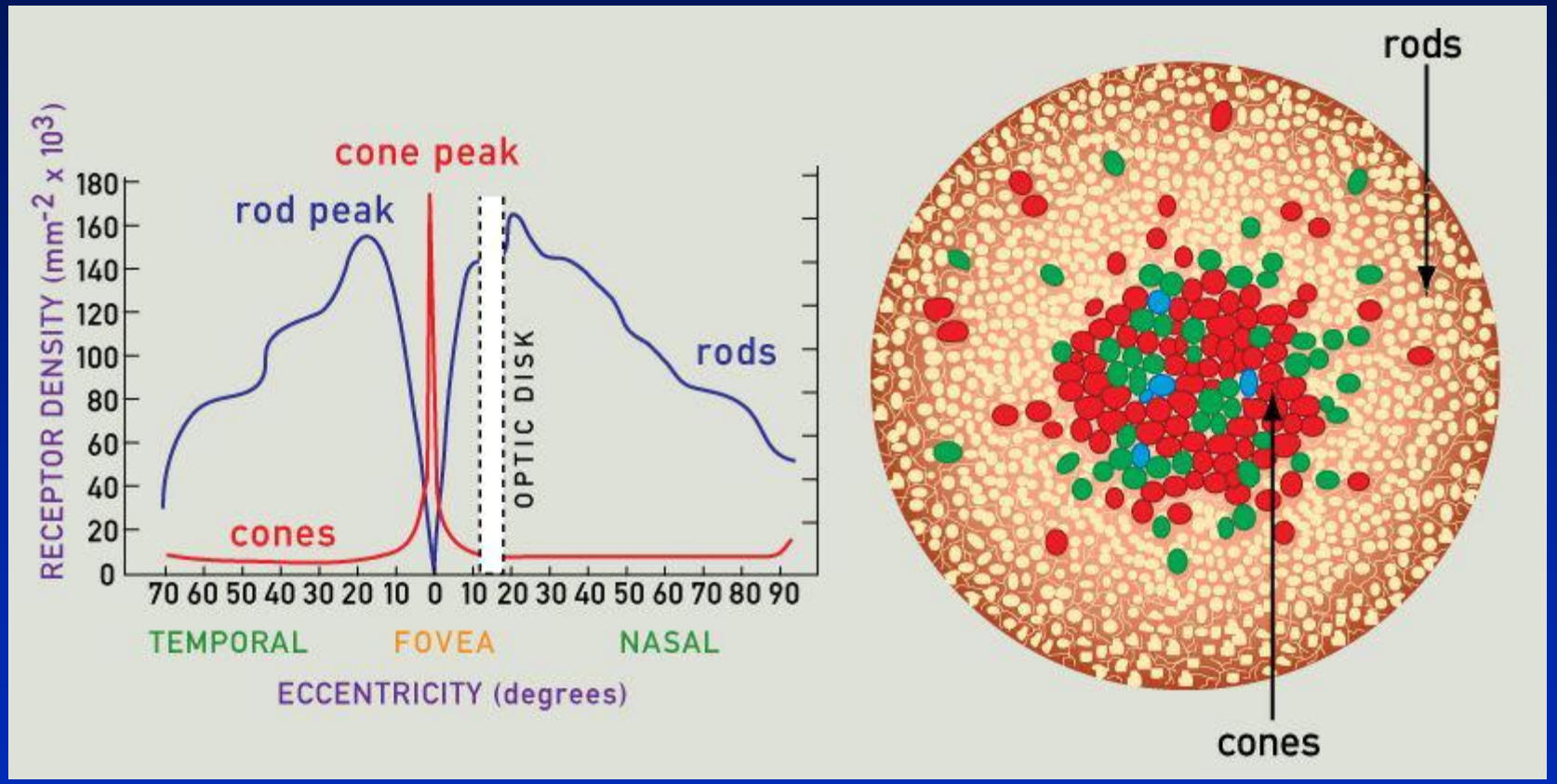
Field of View of the Human Eye



The visual system includes the retinas, the visual pathway connecting the retinas to the brain, and the visual cortex. The two eyes' fields of view overlap (top).

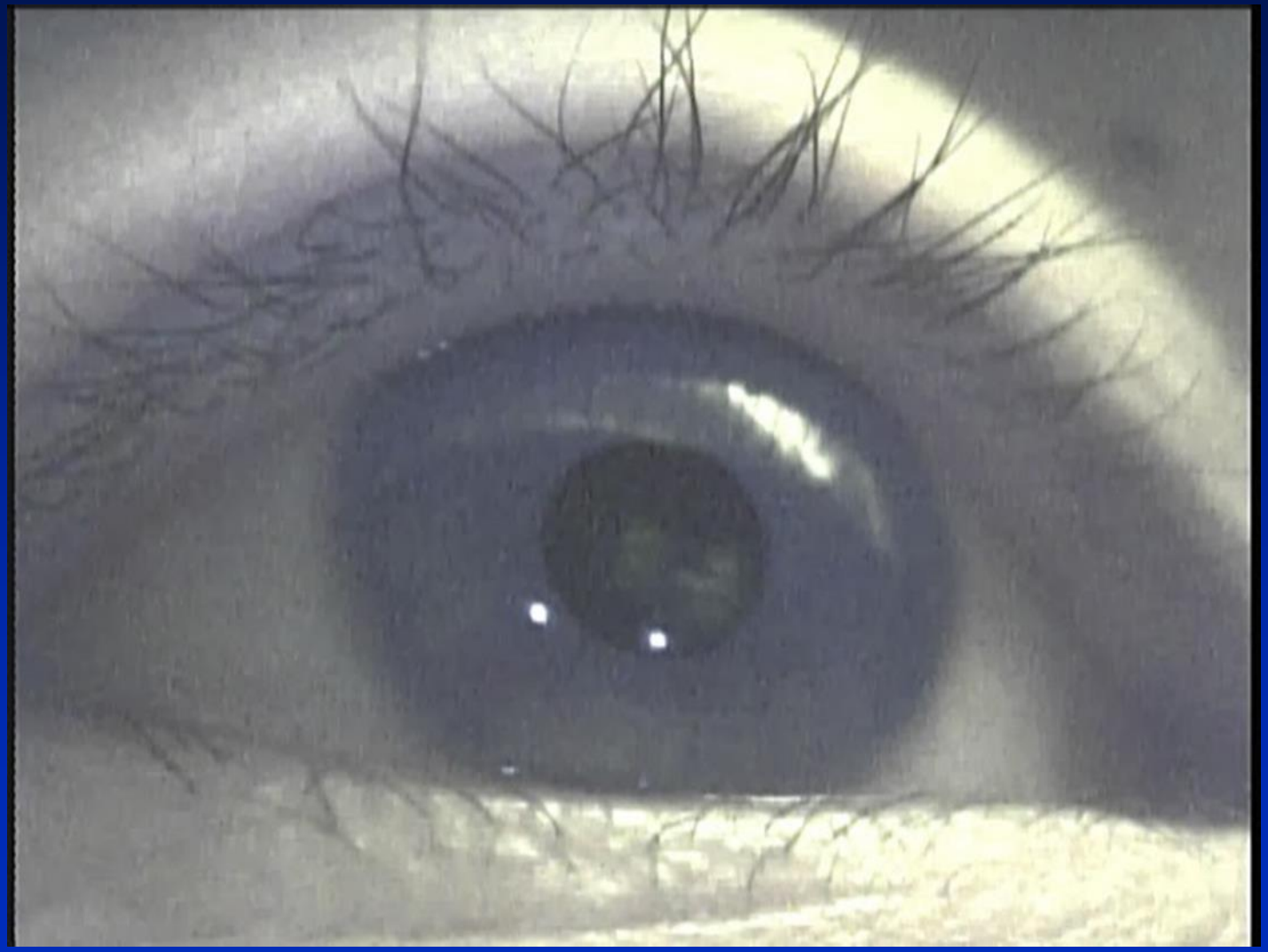
"Foundations of Sensation and Perception." Mather, George. 2009.

Receptor Distribution



Eye Tracking

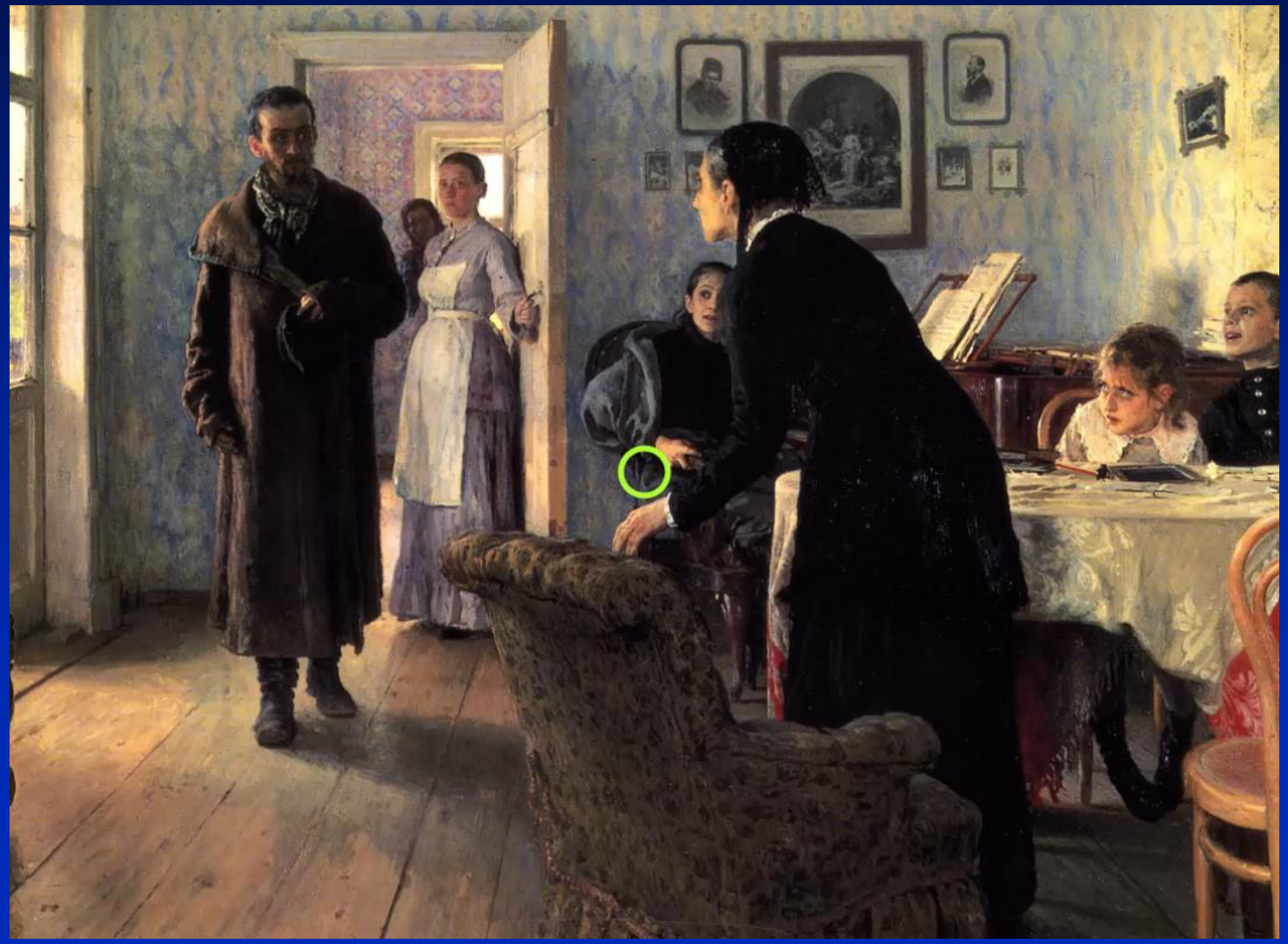
1st and 4th Purkinje Reflections



Saccadic Motion

The eye jumps, comes to rest momentarily (producing a small dot on the record), then jumps to a new locus of interest.

- David H. Hubel. EYE, BRAIN, AND VISION, 1988 Scientific American Books, Inc. p. 80.



End Of Review

Yarbus Heat Maps
1965

Virtual Reality Experiment 2016

Augmented Reality

- Augmented Reality (AR) is a combination of real and virtual worlds
- This is a more difficult problem since the accuracy in terms of geometry, lighting, color, etc. of the simulated (virtual) model must match the characteristics of the real environment in order to create the perception of presence.

Augmented Reality

Augmented reality is the interpretation of digital graphical information with live video or the user's physical environment in real time.

UNC

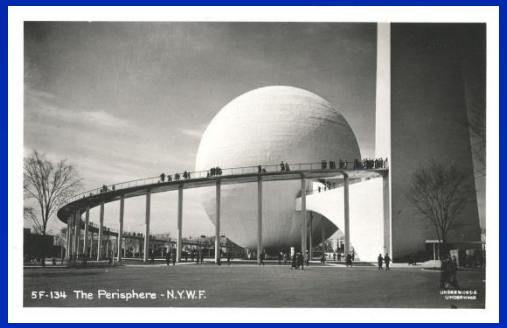
1927: Hoover: Long Distance TV

1950: CBS, Color TV

1996: Telecommunications Act

History of TV

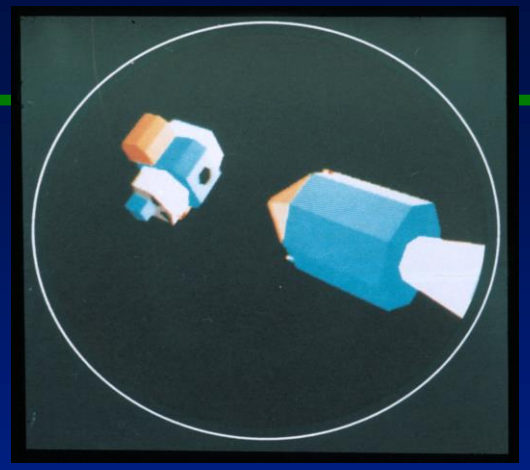
1939: Worlds Fair



1954: First Color TV Broadcast

82 Years

2009: Digital TV Mandated



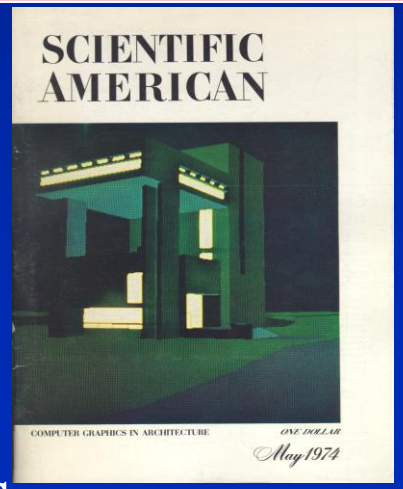
1967: General Electric

1972: Cornell in Perspective

2014: Kitchen Scene

History of Computer Graphics

1974: Scientific American Cover



47 Years

1968: Ivan Sutherland

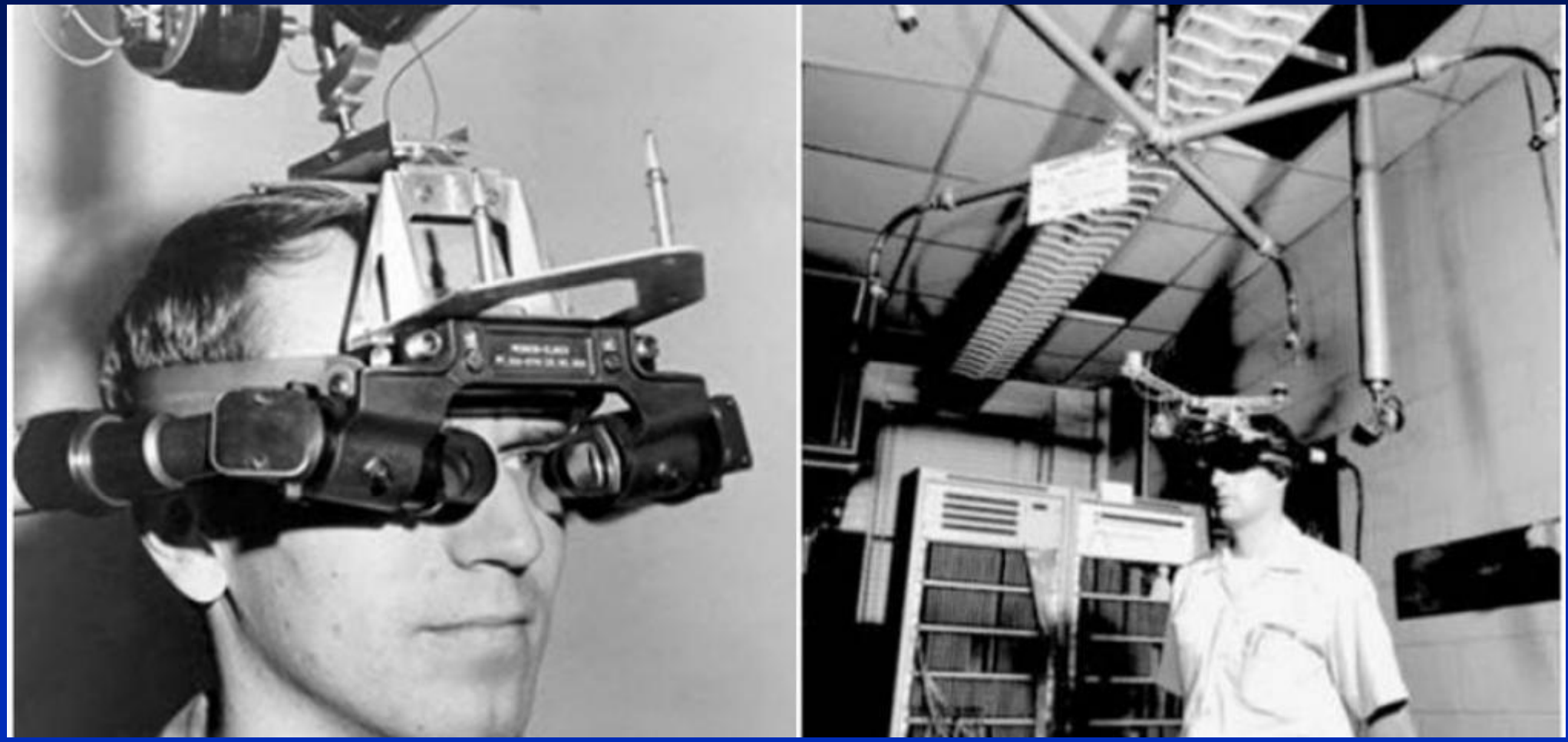
1990s: HMDs, Henry Fuchs

History of Virtual Reality

2016: HTC & Valve's SteamVR Vive

25 years

The Sword of Damocles 1965



Henry Fuchs, UNC 1991

Virtual reality has been introduced a long time ago.

Why should it work this time?

$$$

VR Timeline 2010

- Palmer Luckey starts building VR headsets when he is 18 years old
- Luckey raises funds from kickstarter ($670k in 24 hours)
- John Carmack partners with Luckey

FOV 90 degrees H, 110 degrees V
LCD 1080p (960x1080/eye)
Facebook buys Oculus for $2B
March 25th, 2014

Palmer Luckey 2010

18 years old

Palmer Luckey

John Carmack

Oculus

2017

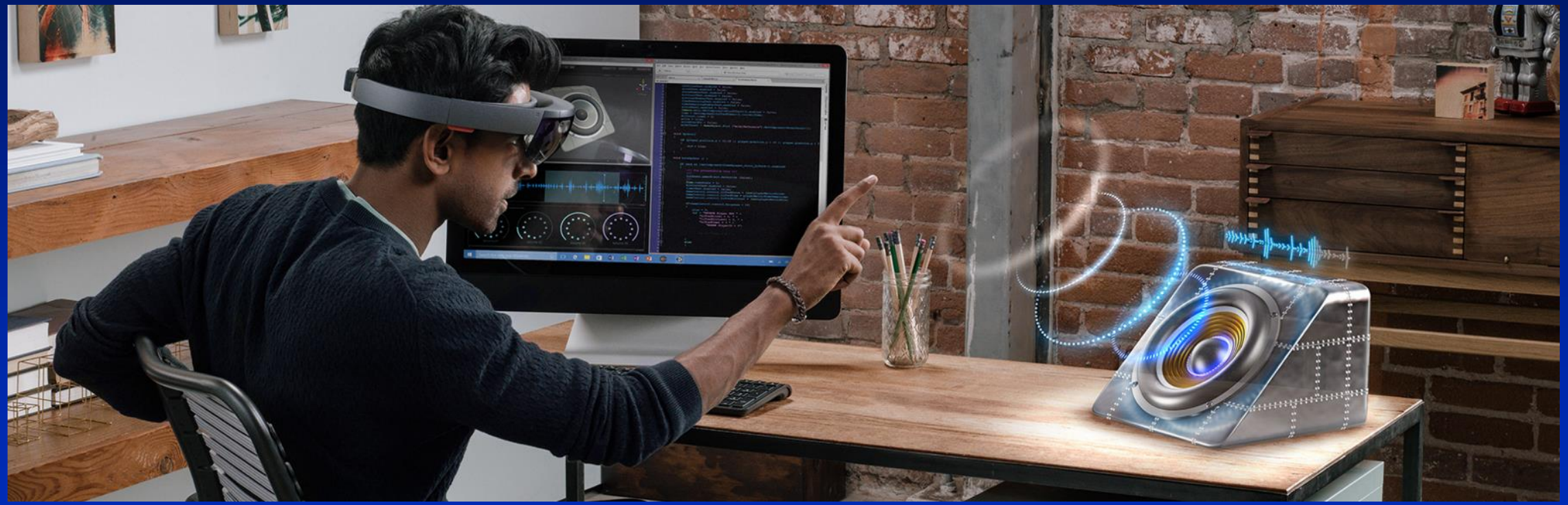
Why did Facebook invest $2 billion in Oculus Rift?

Microsoft buys Minecraft 2014

Why did Microsoft buy Minecraft?

Microsoft's Hololens

Microsoft's Hololens 3/30/16



Google Invests in Magic Leap

Why is Google (and Andressen / Horwitz) investing $500+ million in Magic Leap?

Magic Leap 2015

HTC and Valve's SteamVR Vive 2015

- Introduced at the Game Developers Conference.
- This device was at the high end of the game market with better tracking technology and higher resolution.

HTC and Valve's SteamVR Vive 2016

Oculus Rift

March 28, 2016

Wikipedia

- Oculus VR
- PenTile OLED
- 2160x1200 (1080x1200 per eye) at 90 Hz
- Integrated 3D audio headphones (user removable/exchangeable)
- 6DOF (3-axis rotational tracking + 3-axis positional tracking) through USB-connected IR LED sensor, which tracks via the “constellation” method.

Vive Pro VR Goggles

June 2018

OLED

3K resolution

615 ppi

Oculus Rift- 2019

Oculus Rift

1080x1200/eye

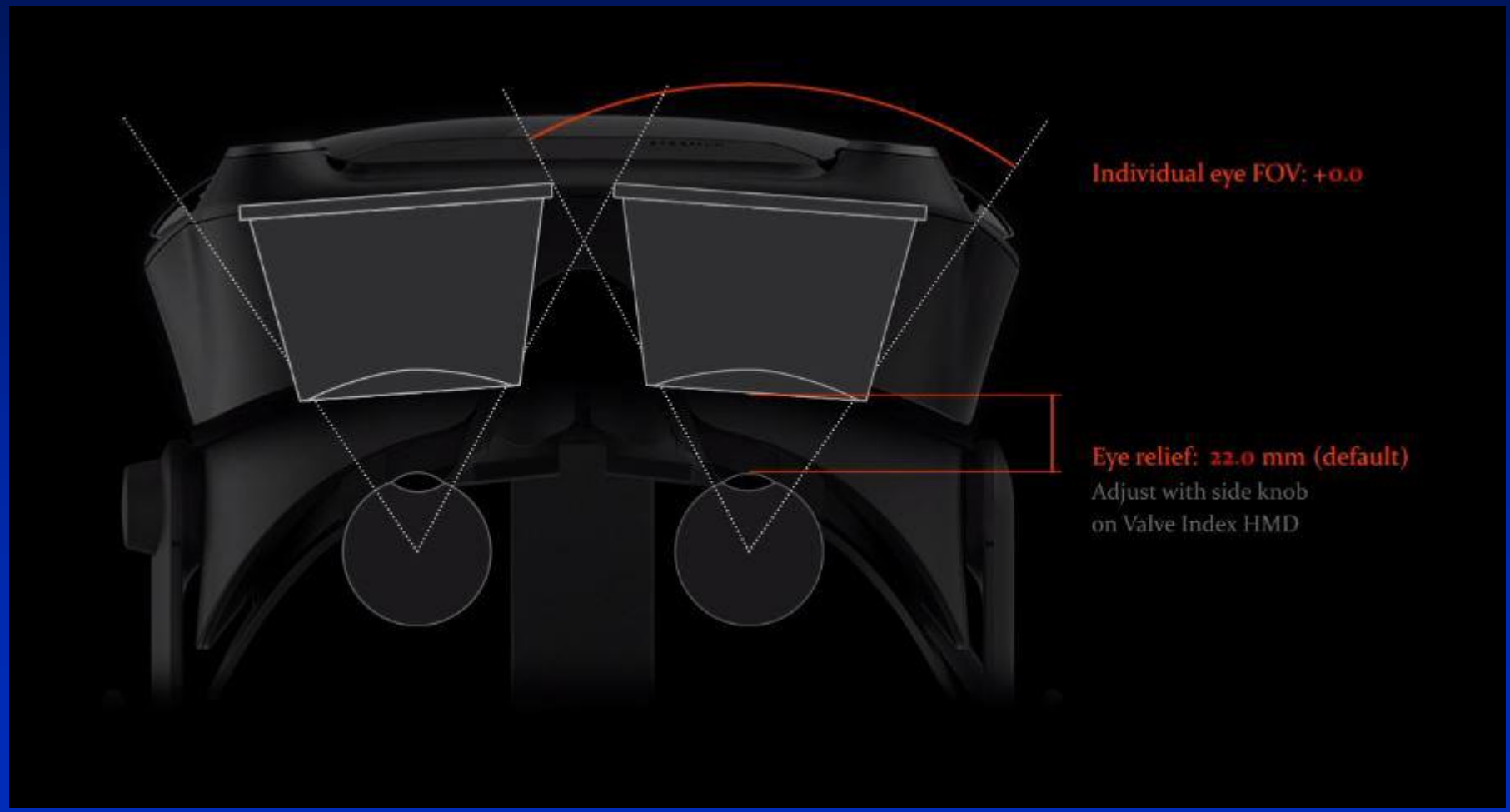
($399)

Head Mounted Displays 2019

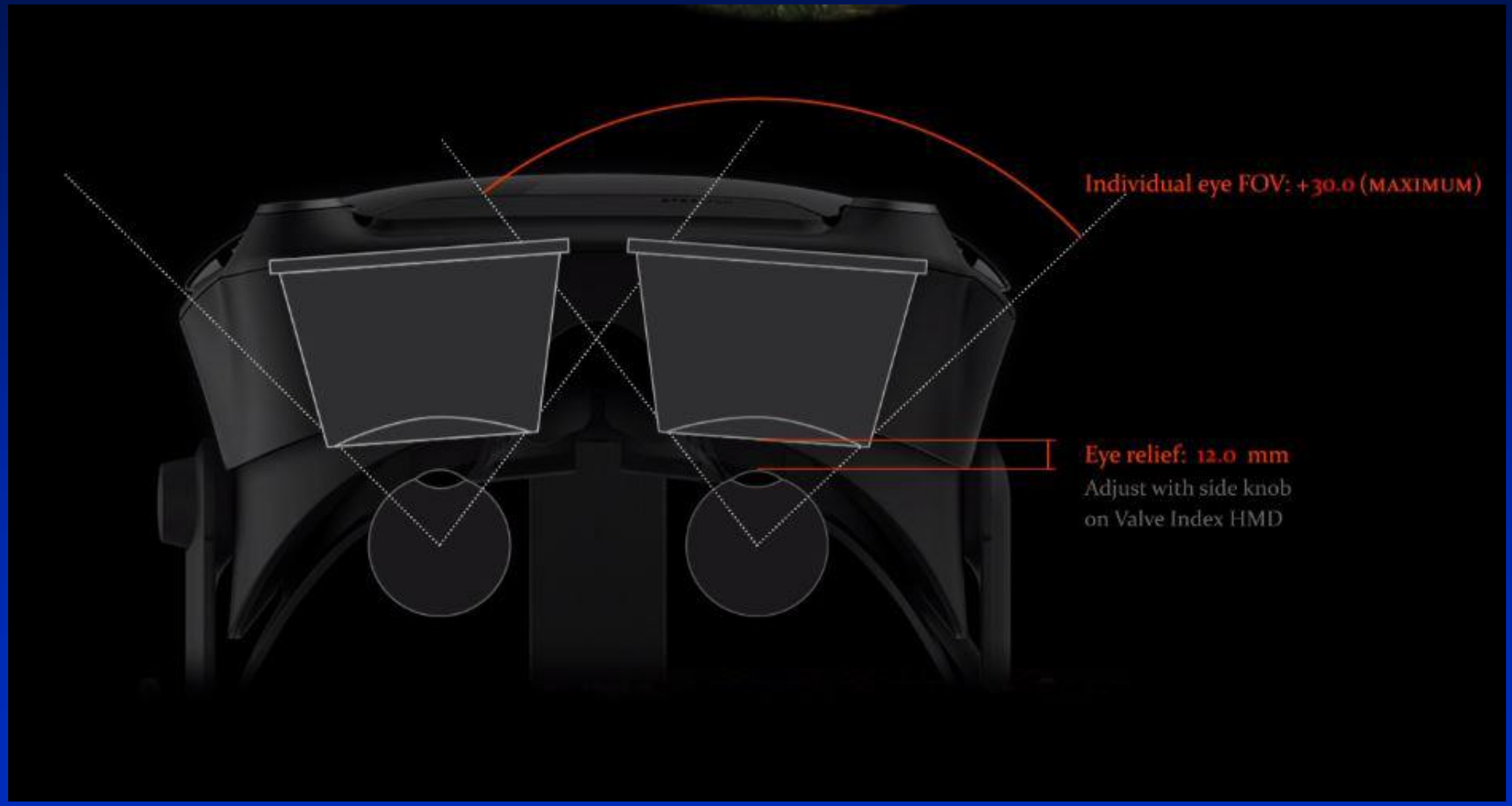
Pimax 5k+ VR Headset
200 degree FOV
Dual 2560 x 1440 LCD
($999)

Valve’s Index 2019

Valve Index 2019



Valve Index 2019



Magic Leap's Mica 2019

Magic Leap's Mica 2019

Virtual reality has been introduced a long time ago.

Why should it work this time?

$$$

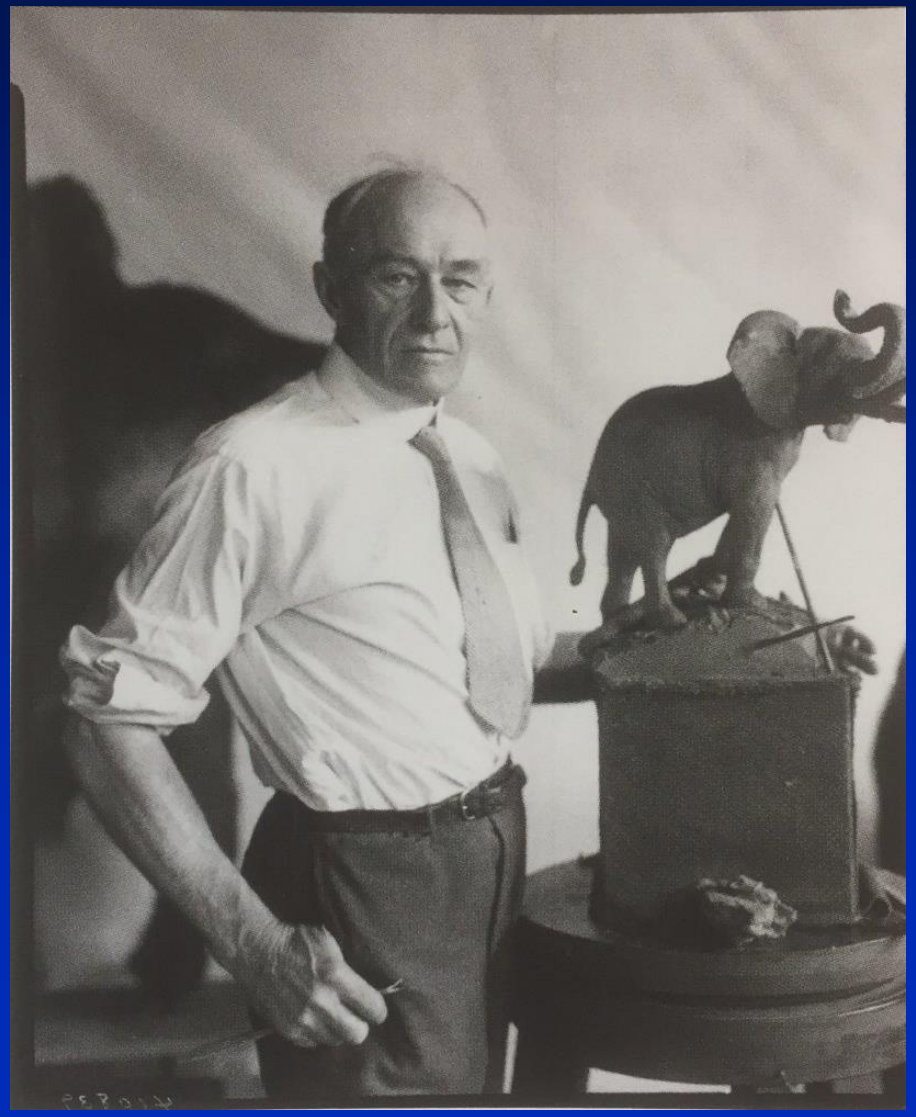
We have solved many (but not all) of the problems!

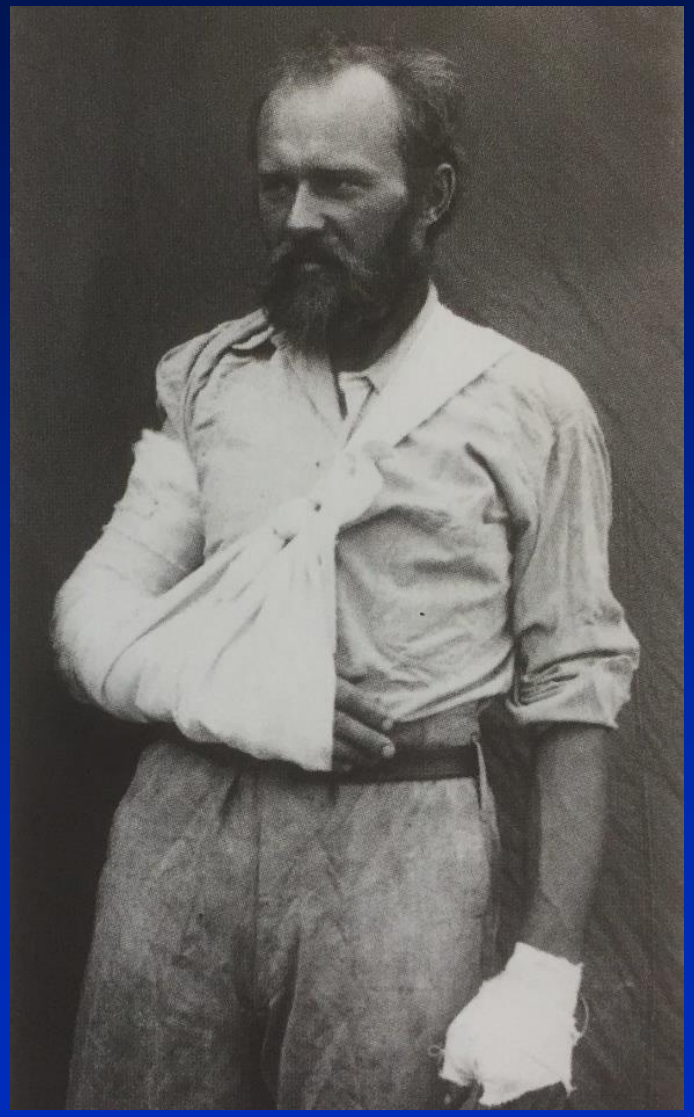
Valve Lighthouse Tracking

Valve Lighthouse Tracking

Dioramas

Carl Akeley





Plan of Typical Diorama

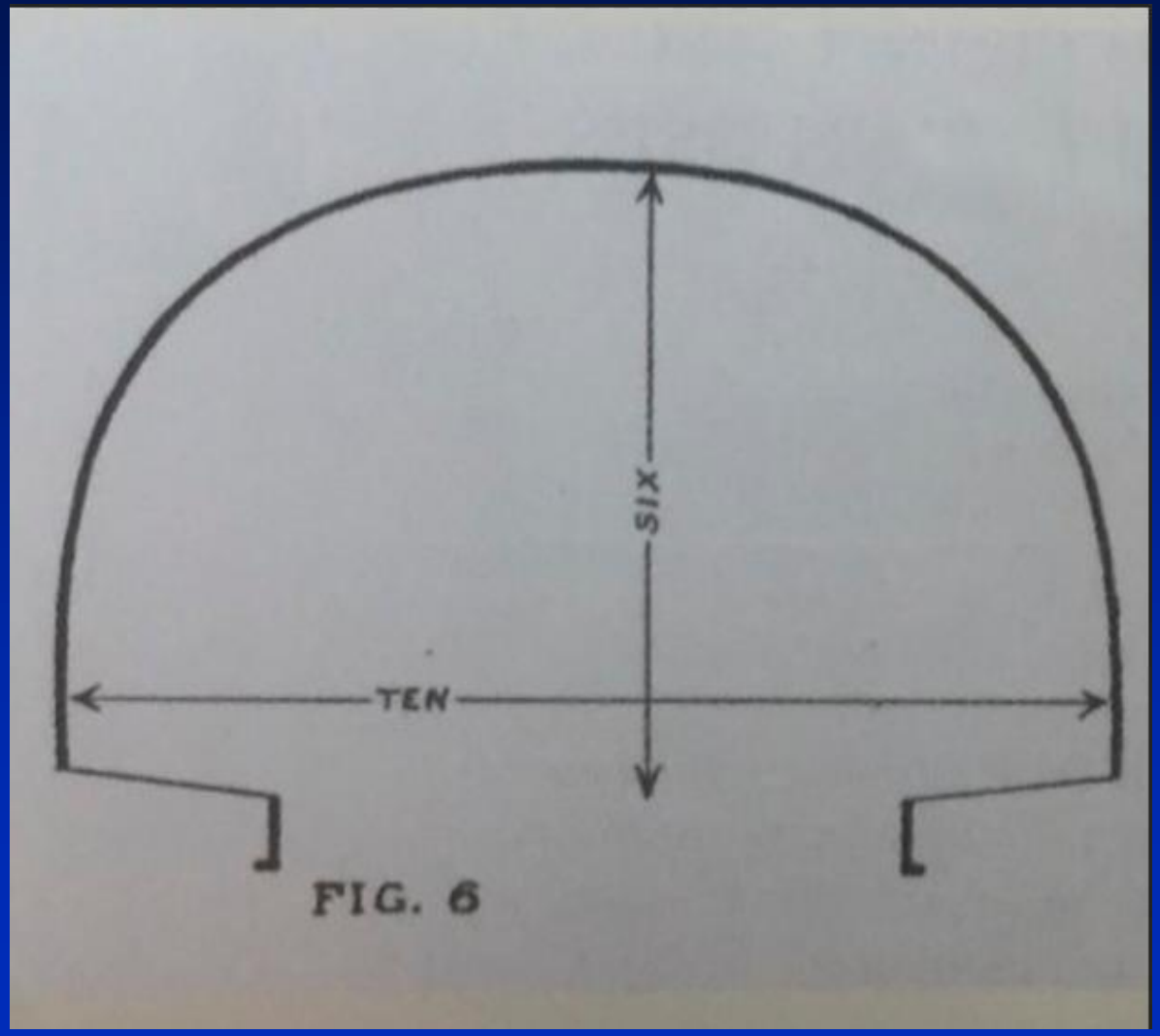


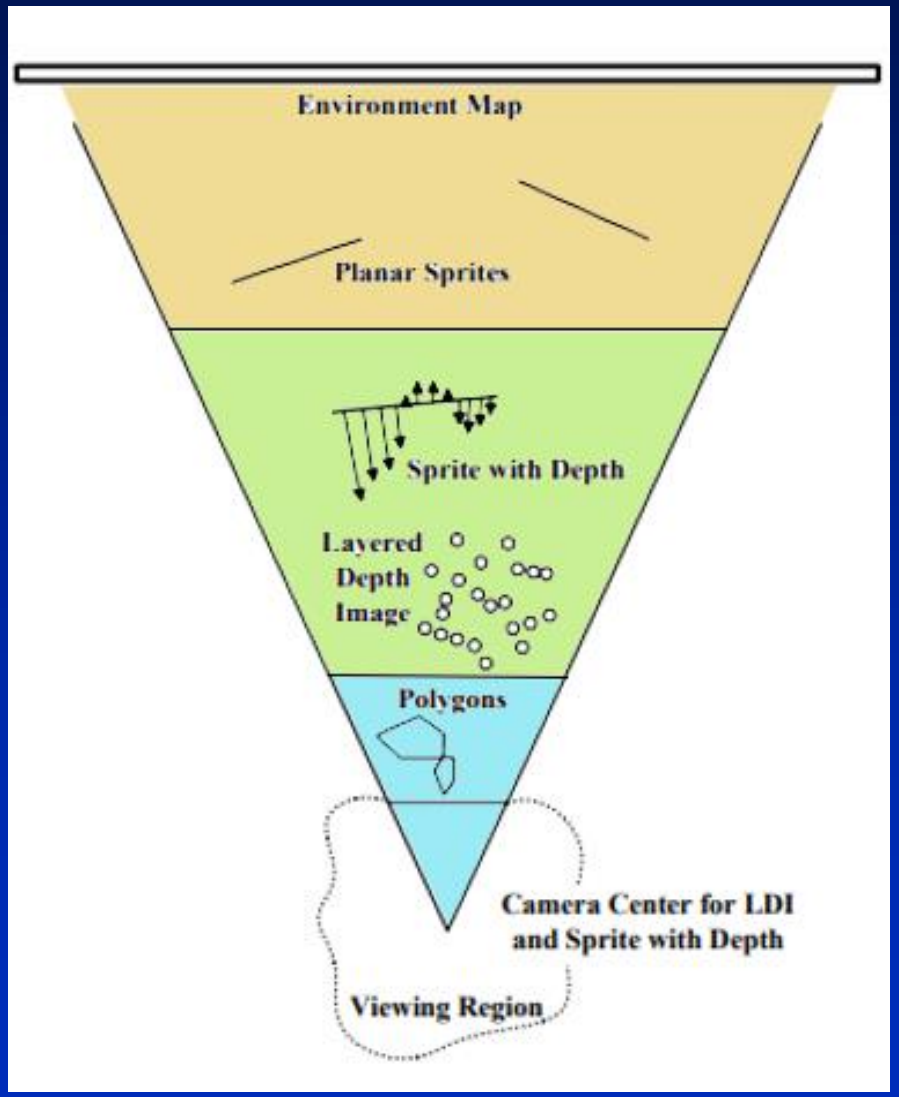
FIG. 6

Alaskan Moose Diorama

Dall Sheep Restoration

Alaska Brown Bear Diorama

LOD Image Based Primitives



Layered Depth Images

Potential Improvements

Reduction in computational time (computer power)

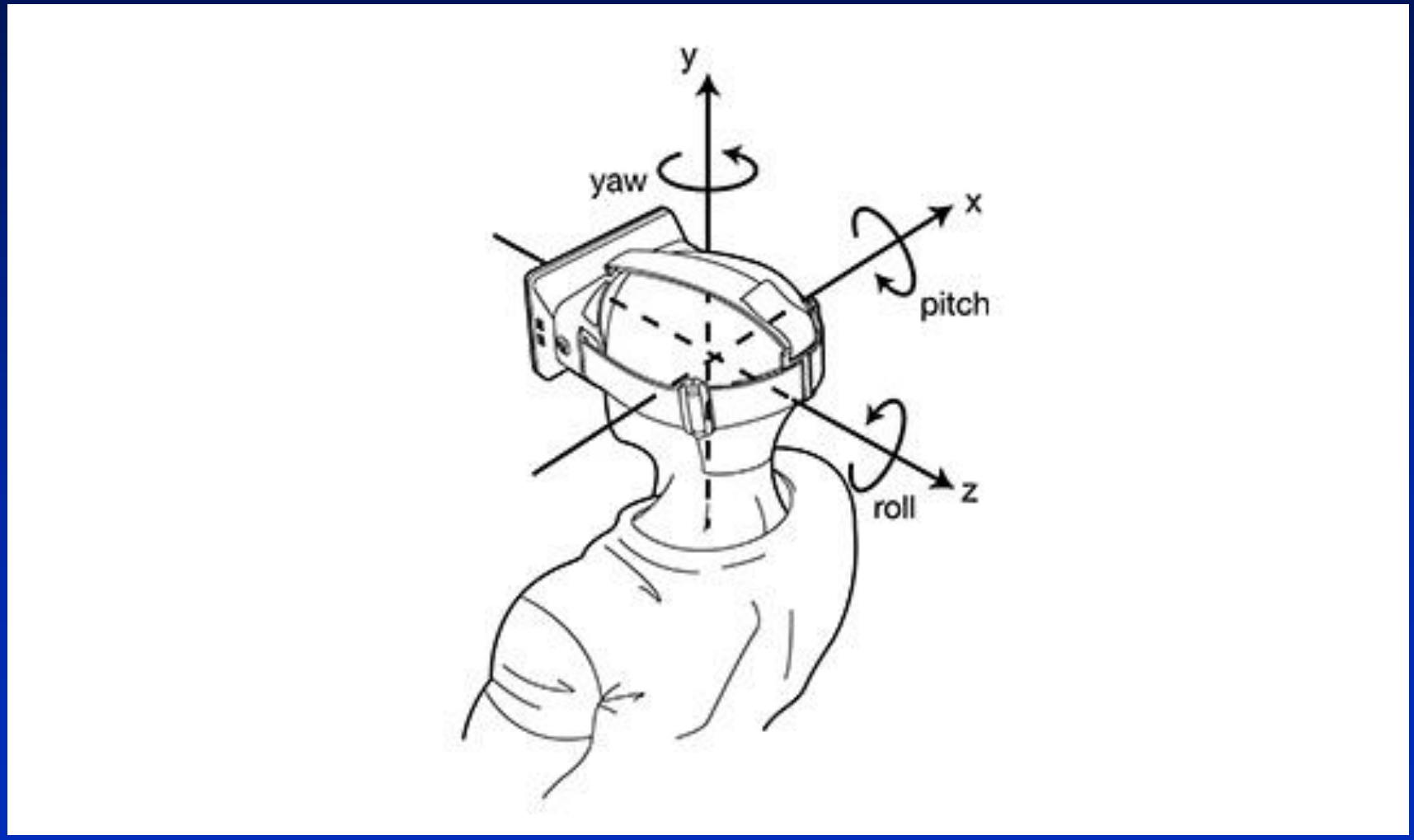
Eye tracking and foveal rendering

Multi resolution displays

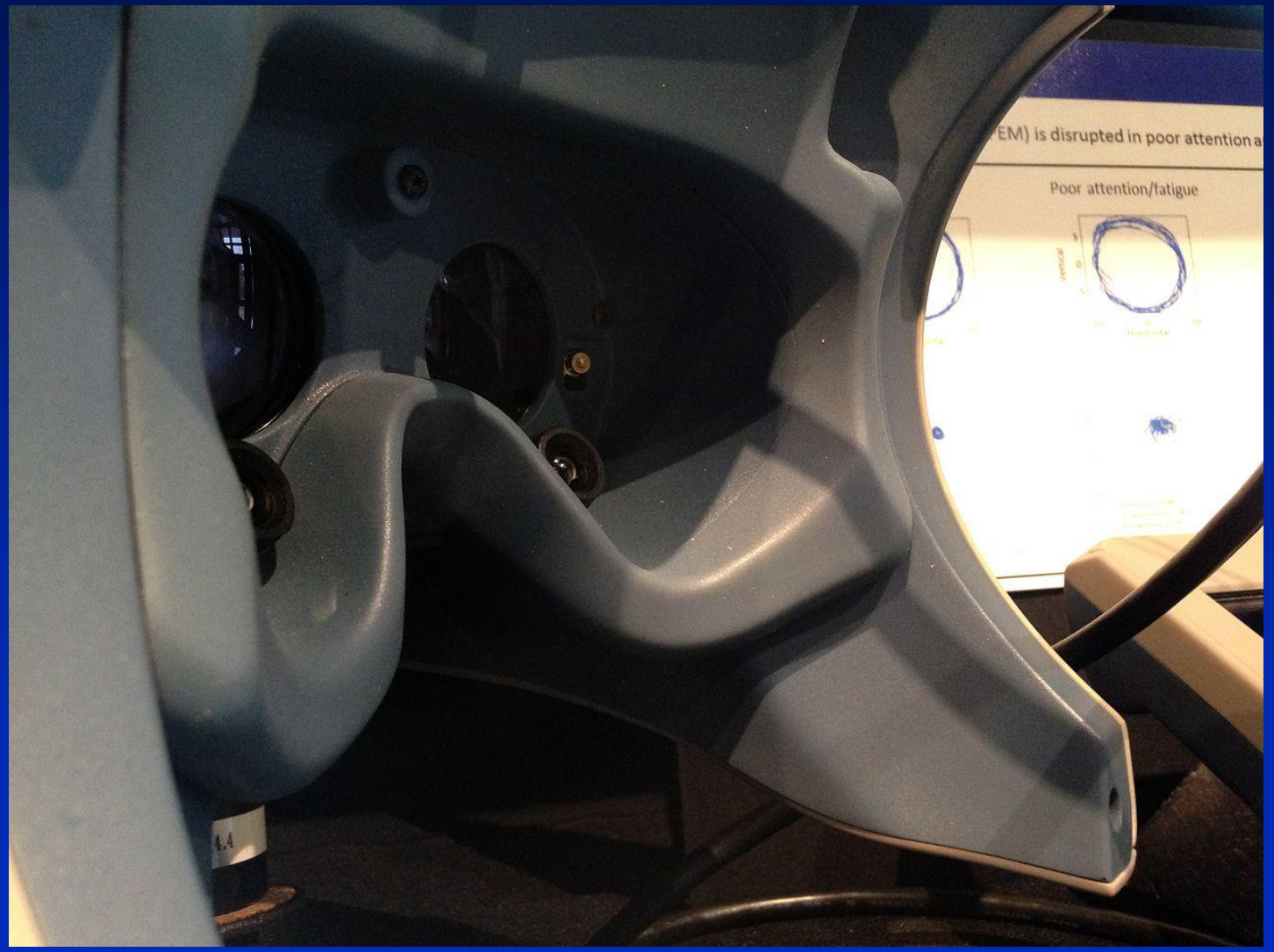
Foveal Rendering

Monoscopic vs. Stereoscopic level of detail

Viewer Position and Head Tracking



Eye Tracking Head Mounted Display



Wikipedia

VARJO's Multi-resolution Display Patent

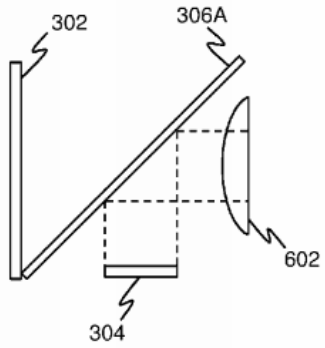


FIG. 6A

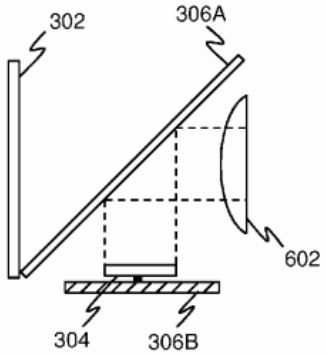


FIG. 6B

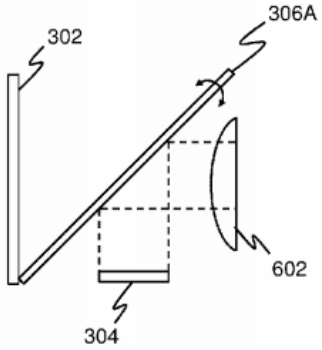


FIG. 6E

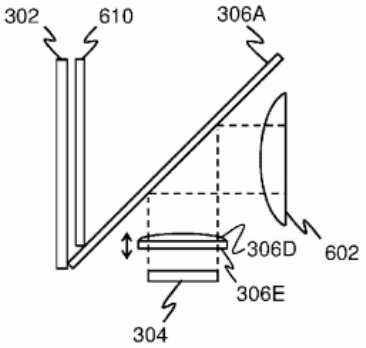


FIG. 6F

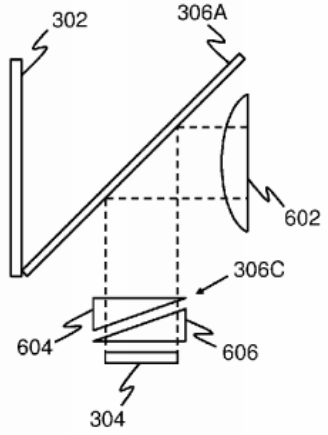


FIG. 6C

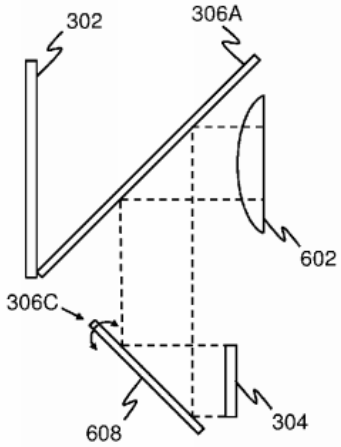


FIG. 6D

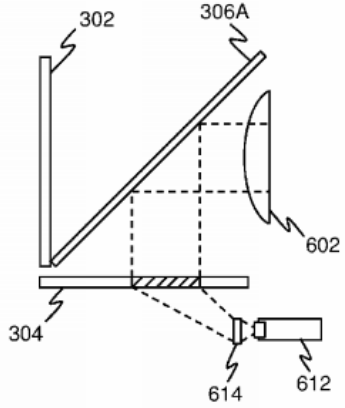


FIG. 6G

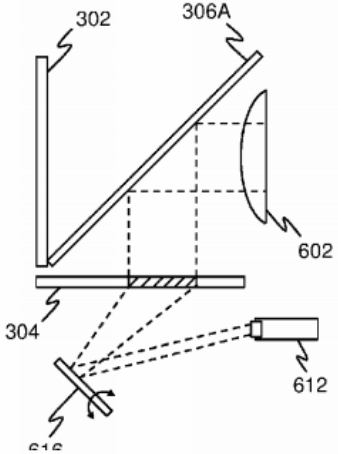
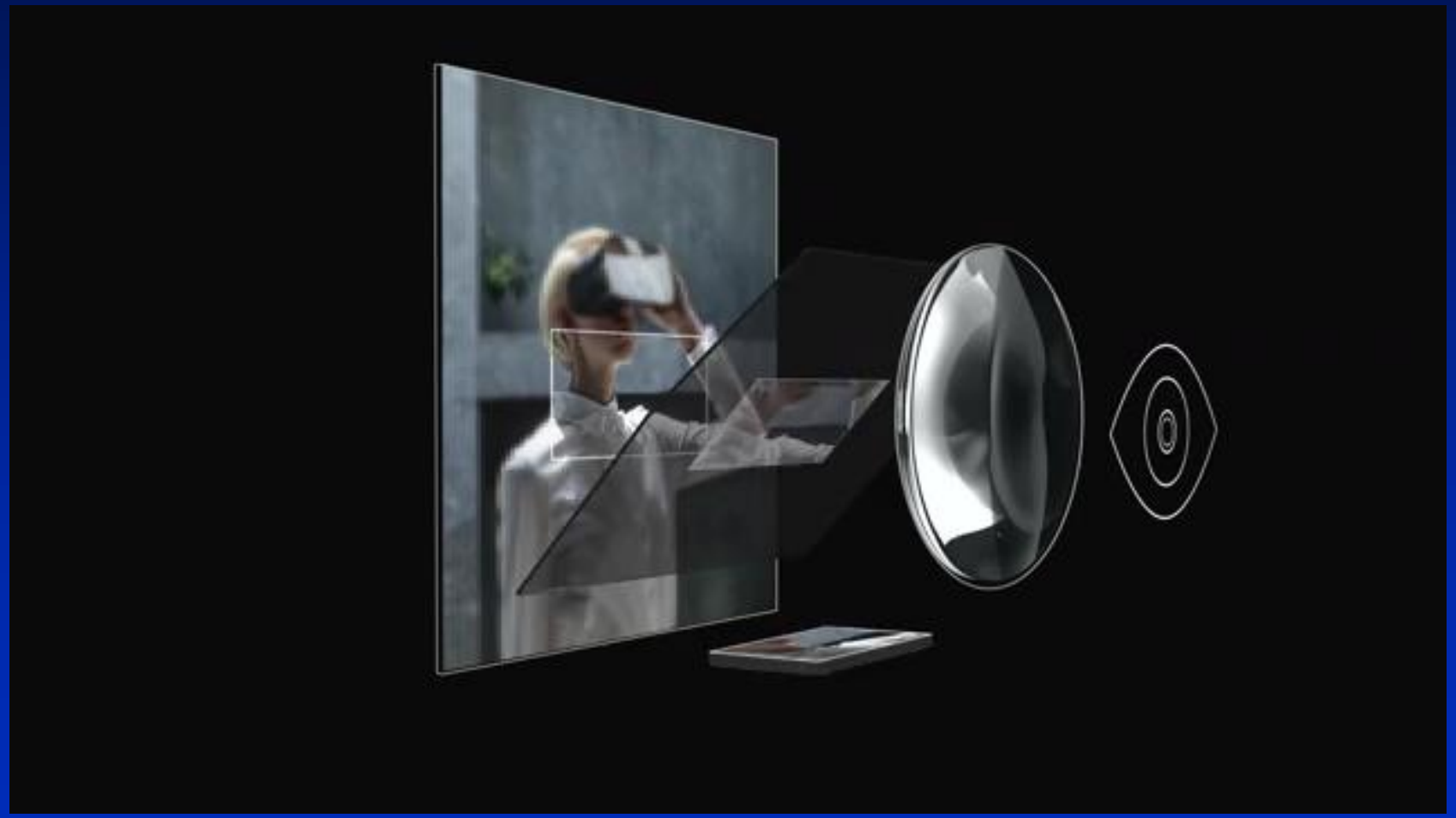


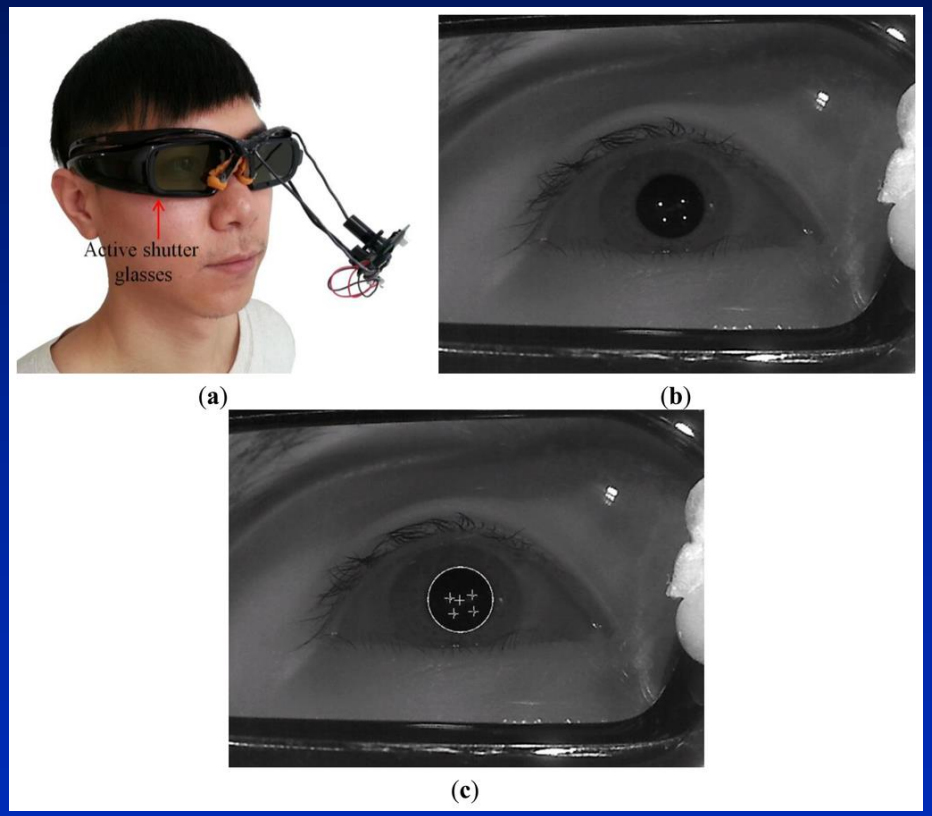
FIG. 6H

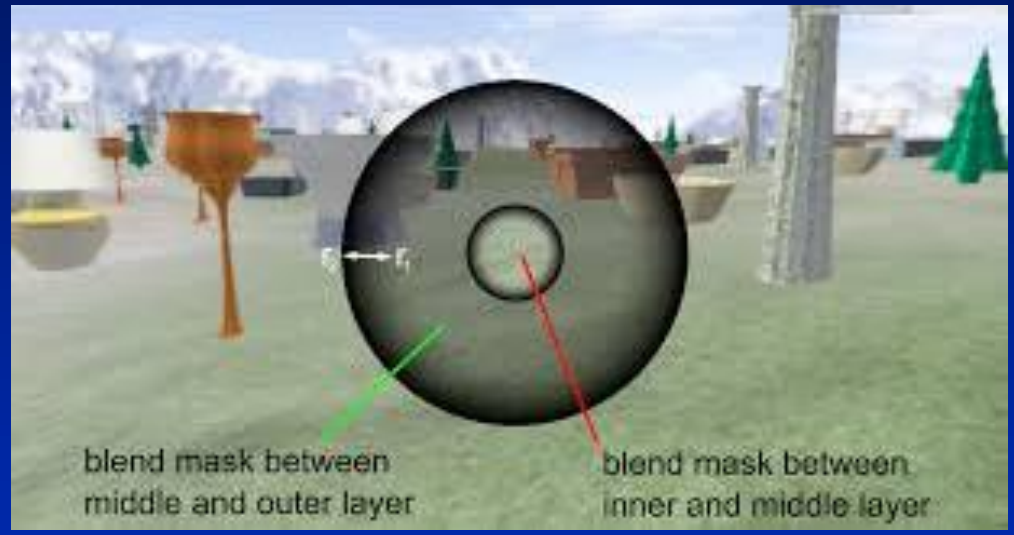
VARJO’s Multi-resolution Display



October 2018

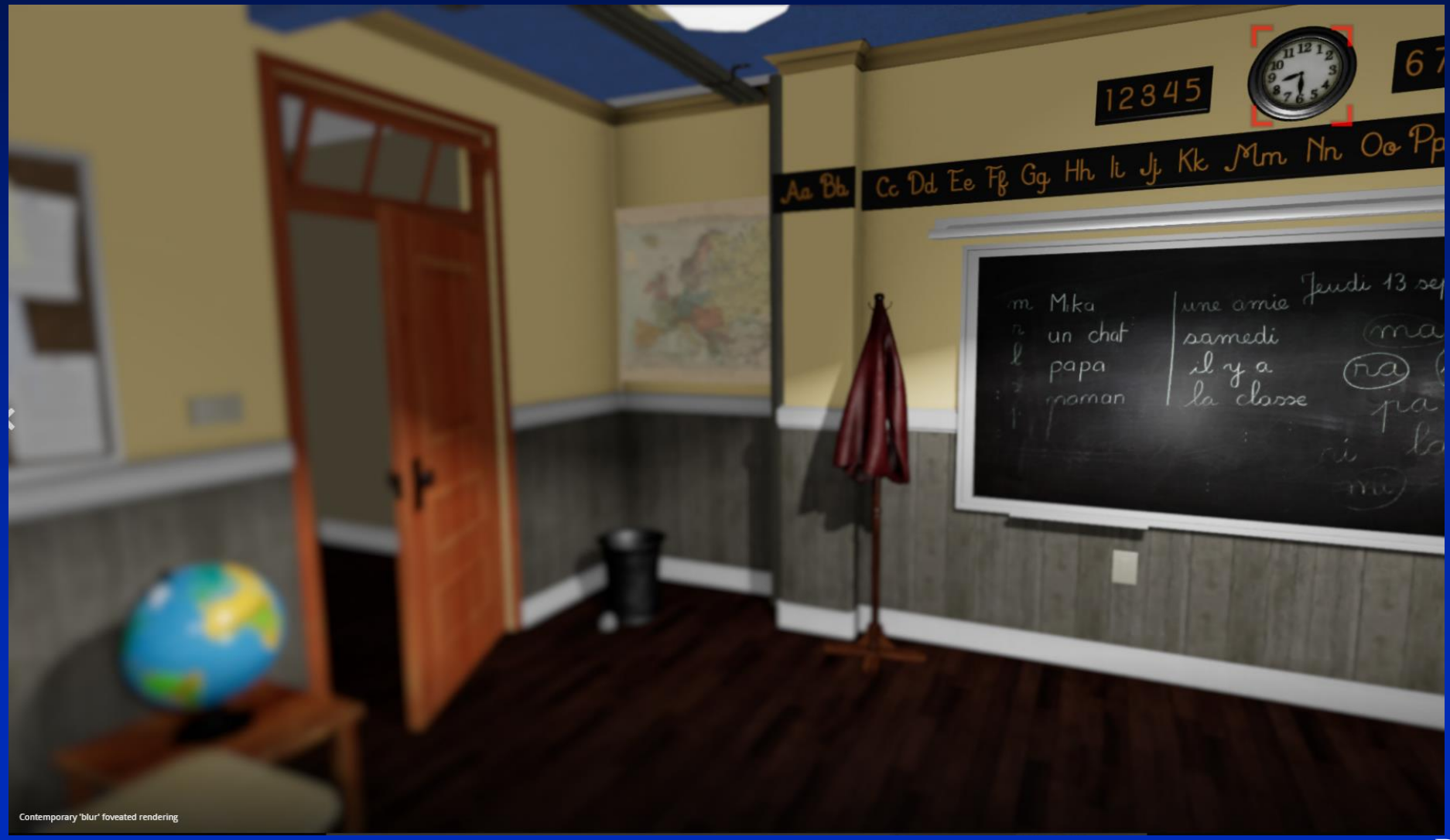
Research on Foveated Displays



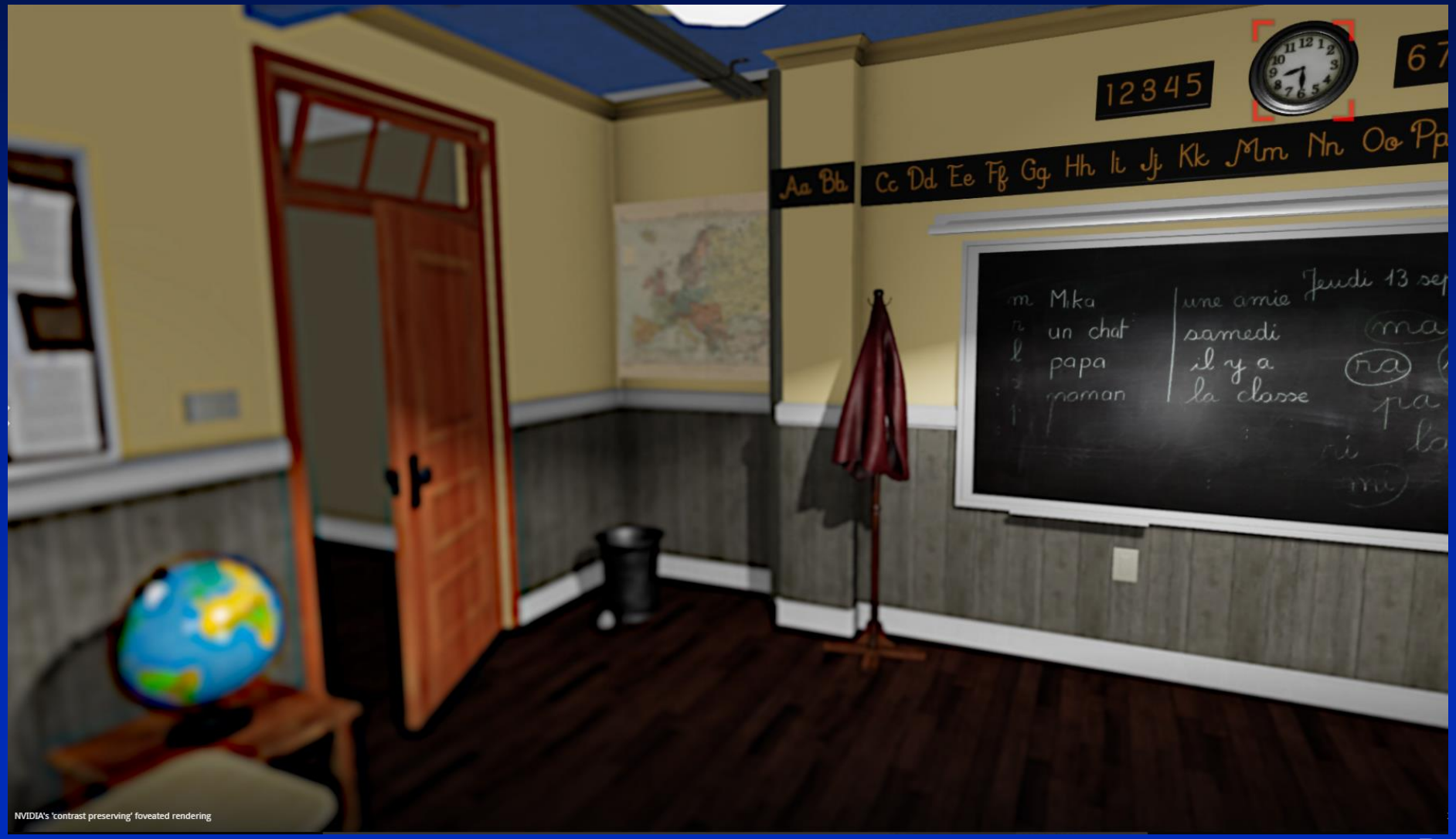


No Foveated Rendering

Contemporary ‘blur’ foveated rendering



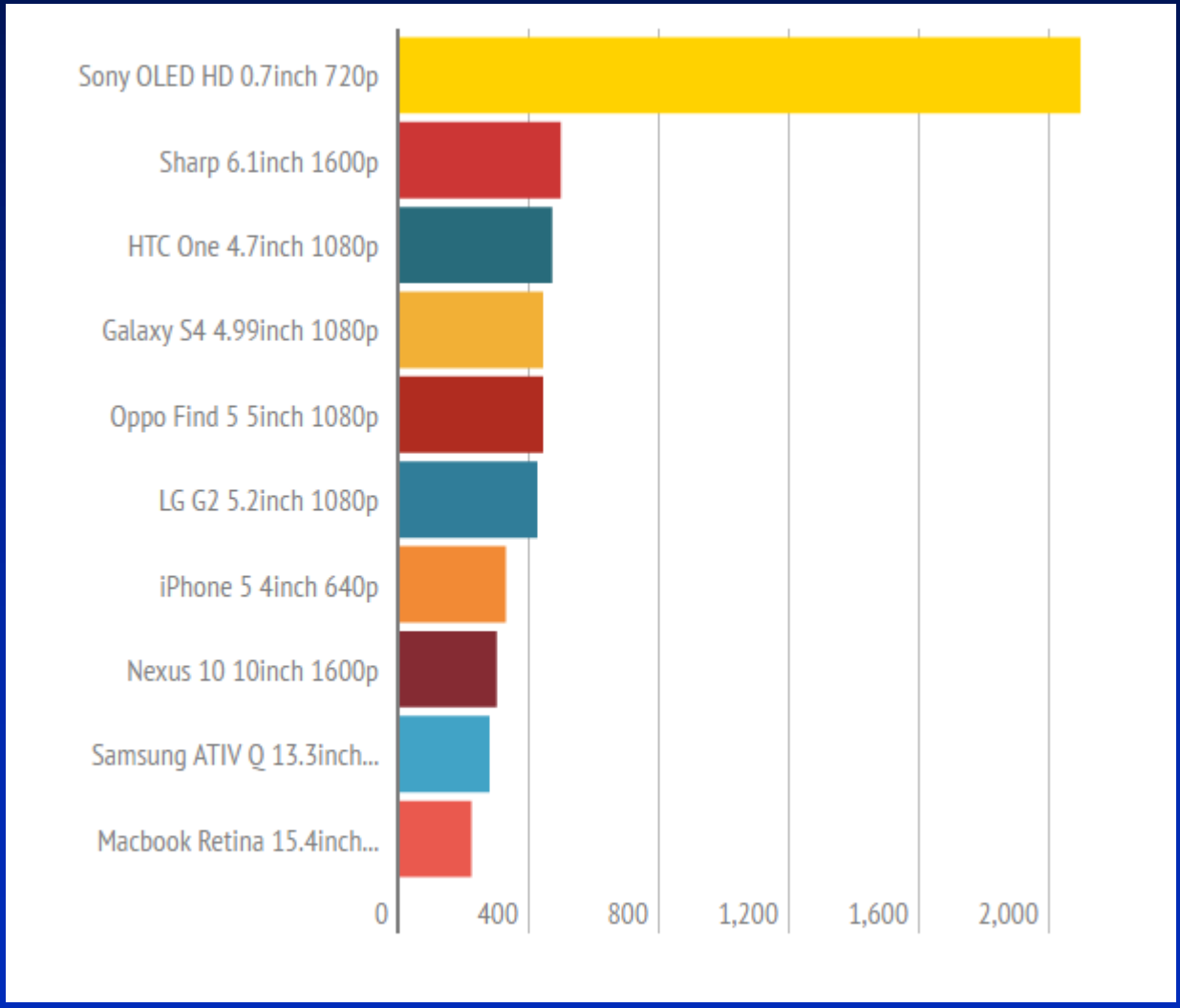
NVIDIA’s ‘contrast preserving’ rendering



Roadtovr.com

End

Increasing Densities (ppi) of OLED Displays



Grand Moff Tarkin Peter Cushing

Performance Capture

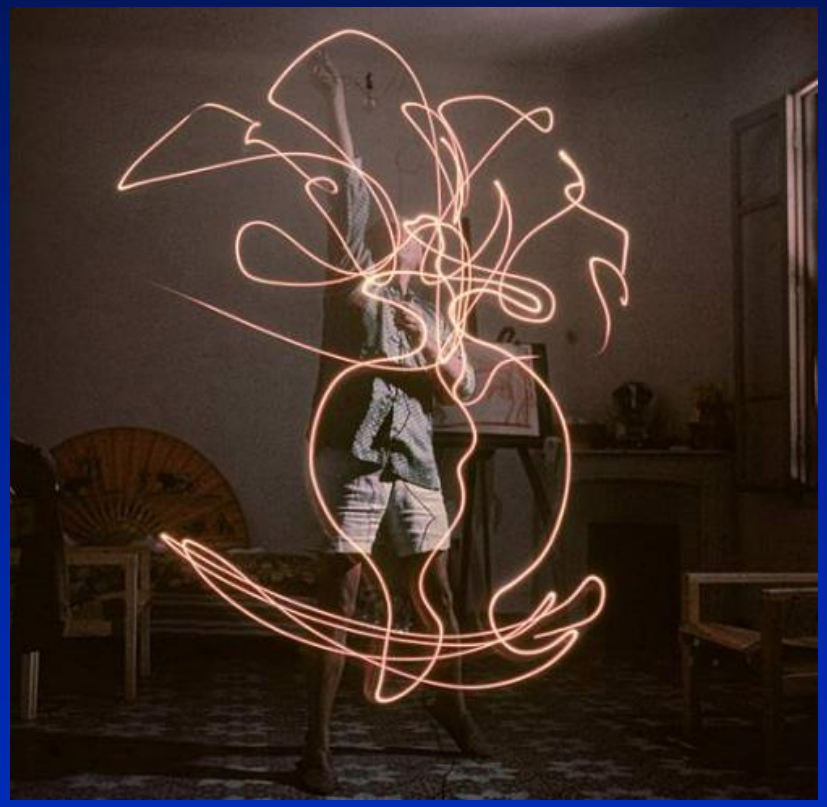
Guy Henry

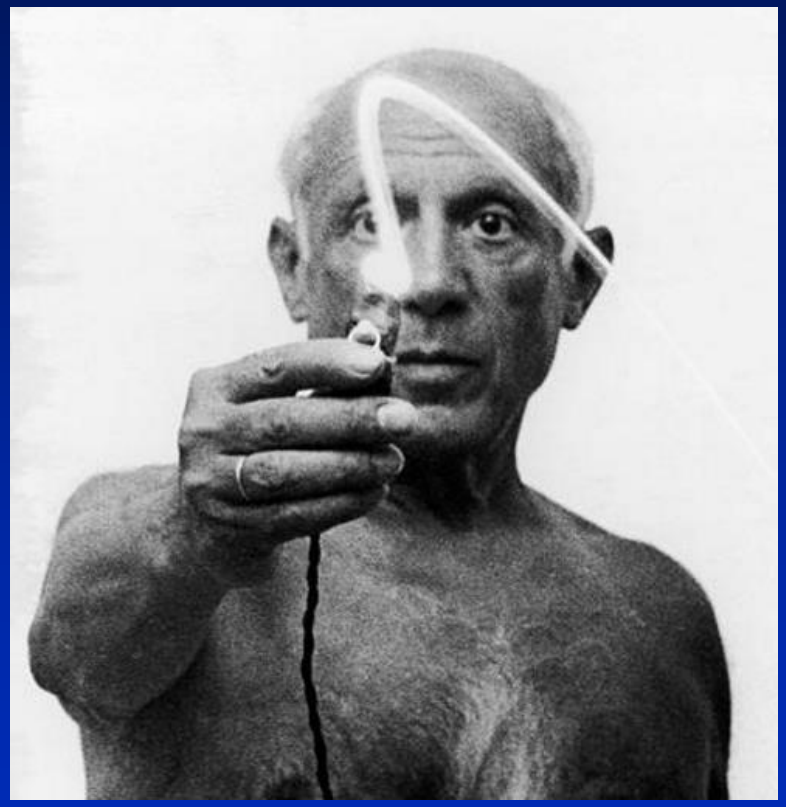
Grand Moff Tarkin

Rogue One 2049

War for the Planet of the Apes

Pablo Picasso Light Paintings, 1949



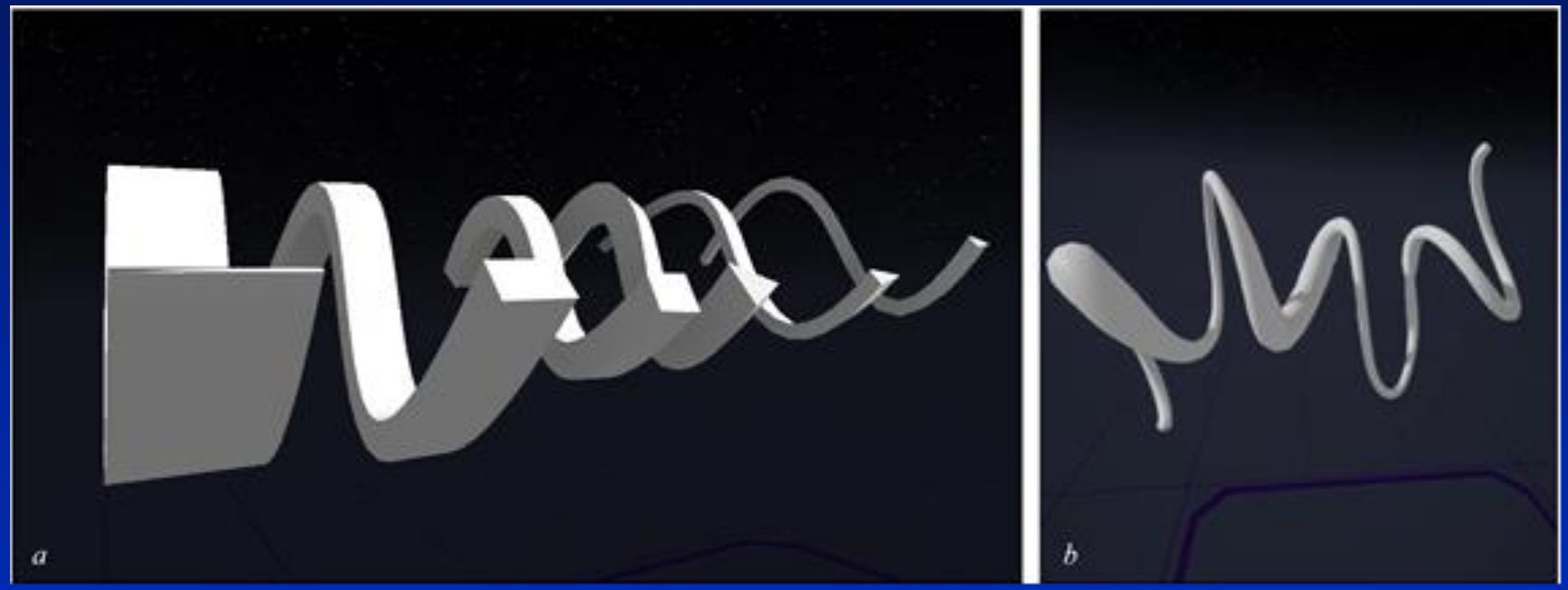


Tilt Brush

Google

V-Spline

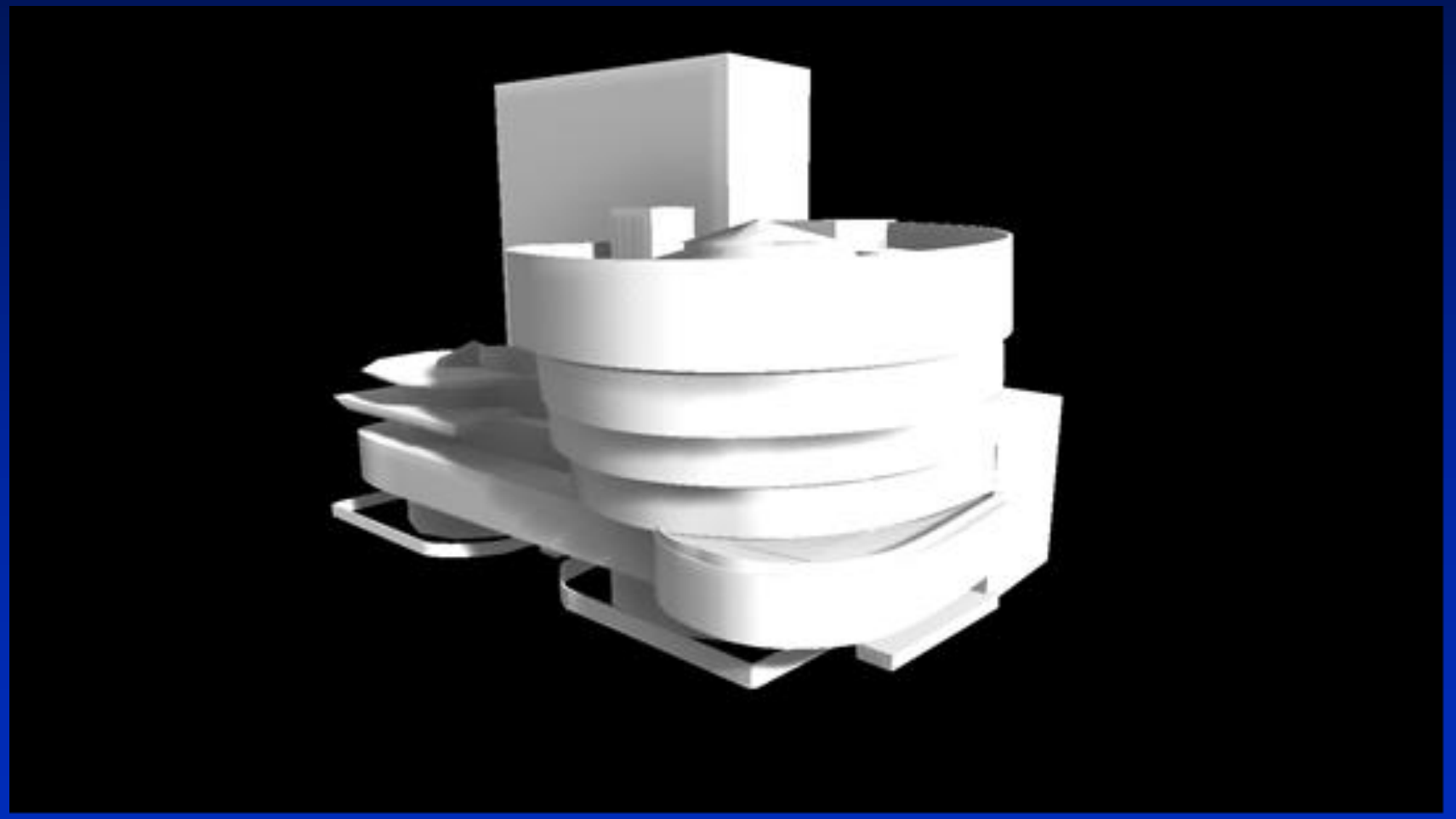
Chris, Ethan, and Don



V-Spline Models

Rachel Stein

Guggenheim V-Spline, 2017



Valve Index 2019

Valve Index VR Headset

1440x1600 LCD/eye

120-144 Hz

Wider FOV

($999)

Nvidia RTX 2080 ti 2019

North American Ice Age Diorama