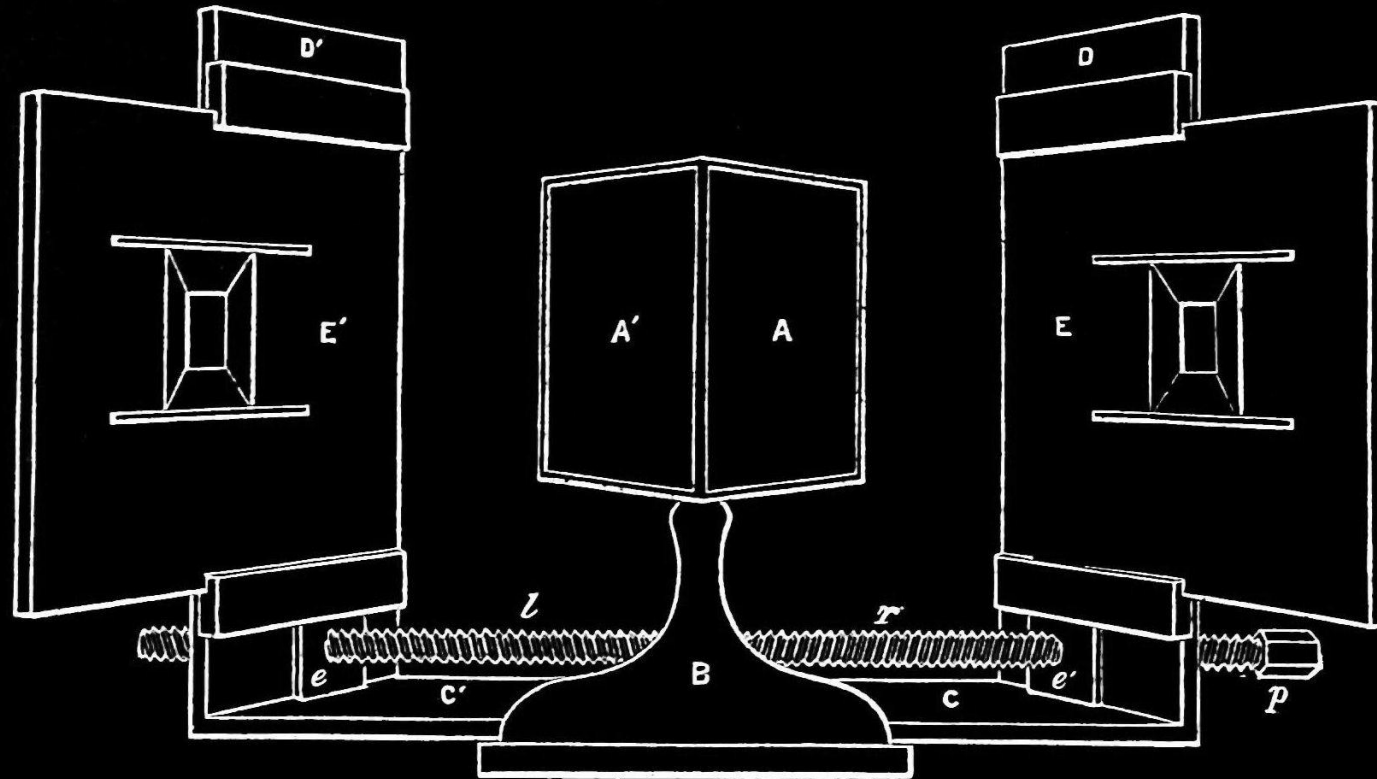


History of Virtual Reality

Reading: *3D User Interfaces: Theory and Practice (2nd Edition)*, Ch. 2

Evan Suma Rosenberg | CSCI 5619 | Fall 2020

1838 – Wheatstone Stereoscope



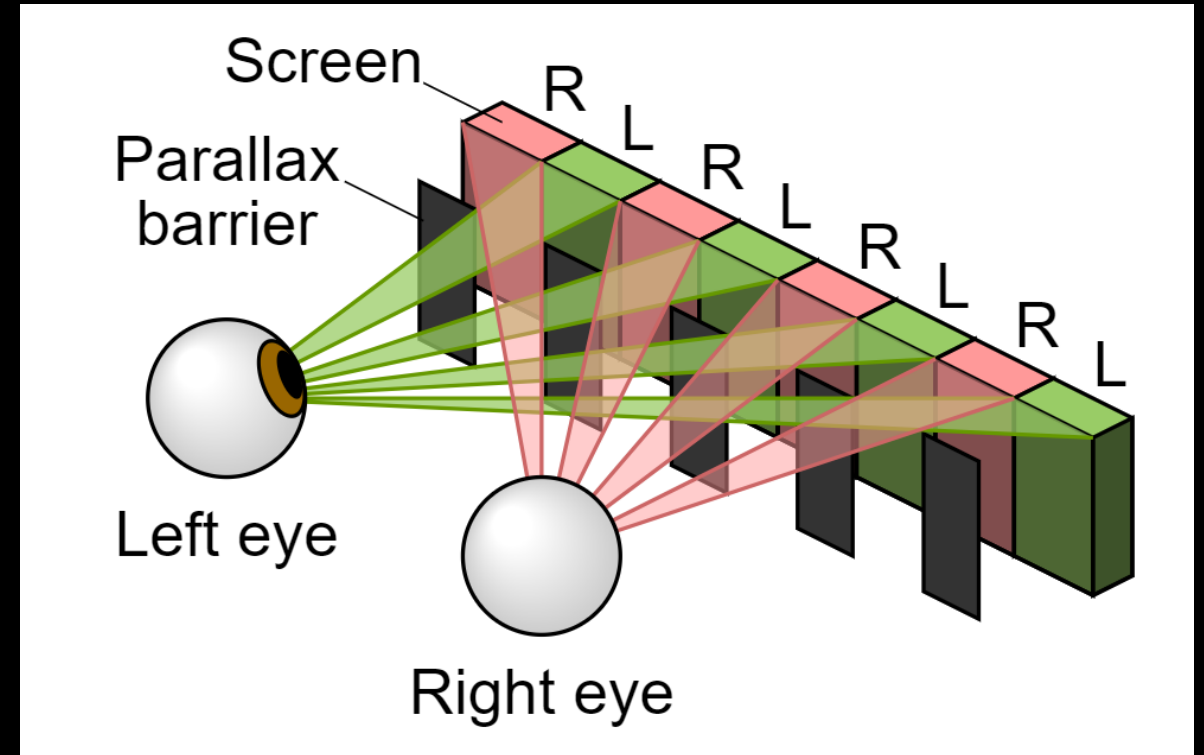
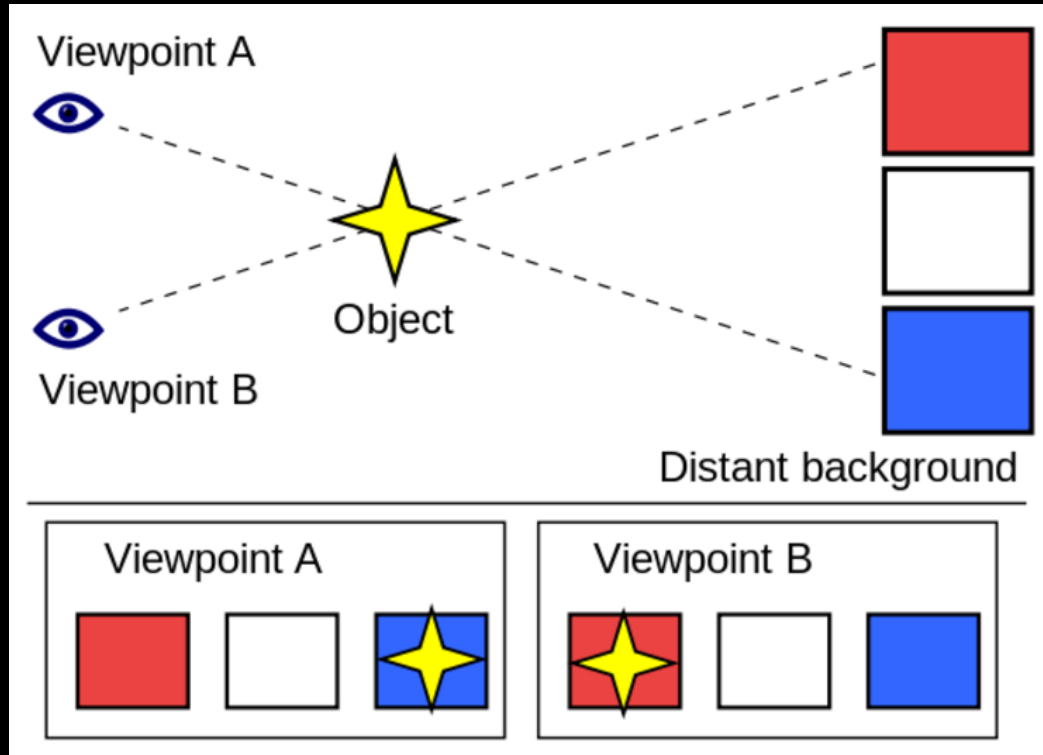
The Wheatstone stereoscope used angled mirrors (A) to reflect stereoscopic drawings (E) towards the viewer's eyes.

1849 – Brewster Stereoscope



P. Hoberman, D. Krum, E. Suma, and M. Bolas. Immersive training games for smartphone-based head mounted displays. IEEE Virtual Reality, 2012.

1903 – Parallax Barrier



1929 – Link Flight Simulator



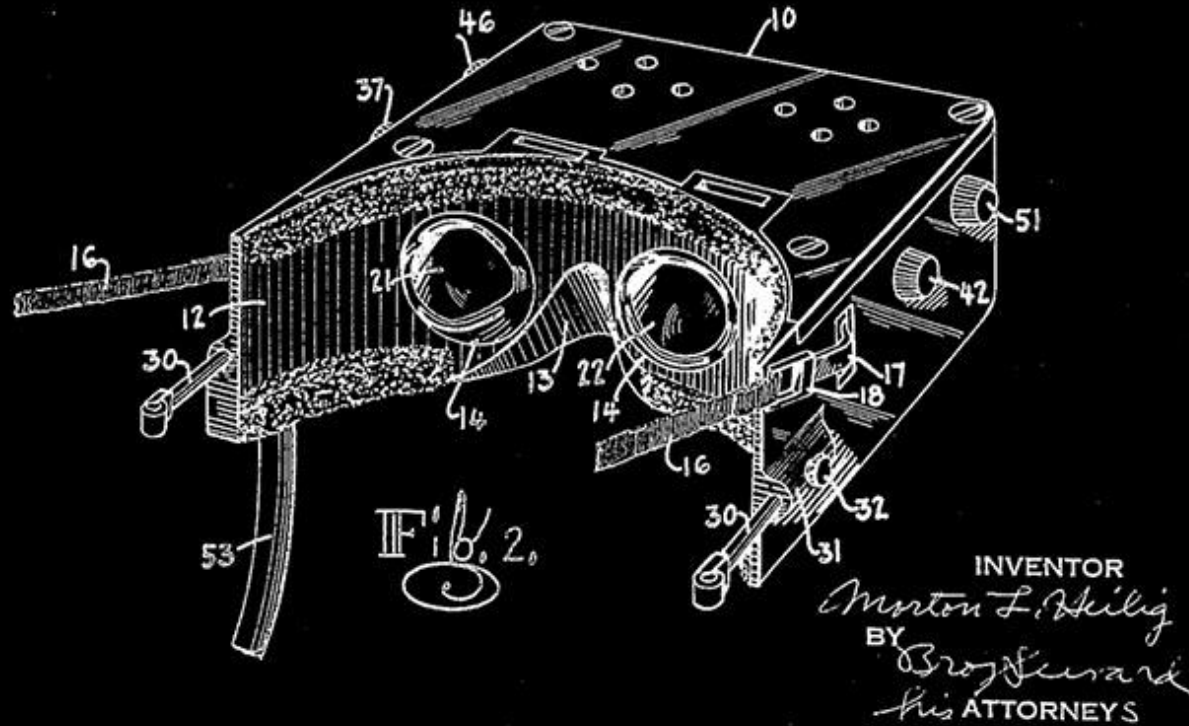
Edward Link developed a mechanical flight simulator for training. Simulator was instrument-only (flying blind with no visuals).

1956 – Sensorama

Morton Heilig's Sensorama was an immersive multisensory experience that combined 3D film, stereo sound, vibration, wind, and even smell.



1960 – Telesphere Mask



The first head-mounted display (HMD) was patented by Heilig in 1960.

1965 – The Ultimate Display

- **3D Display:** “A display connected to a digital computer gives us a chance to gain familiarity with concepts not realizable in the physical world. It is a looking glass into a mathematical wonderland.”
- **Motion Tracking:** “The computer can easily sense the positions of almost any of our body muscles.”
- **Haptics:** “The ultimate display would, of course, be a room within which the computer can control the existence of matter. A chair displayed in such a room would be good enough to sit in. Handcuffs displayed in such a room would be confining, and a bullet displayed in such a room would be fatal.”

1968 - Sword of Damocles

First virtual reality head-mounted display system, created by Ivan Sutherland and Bob Sproull.

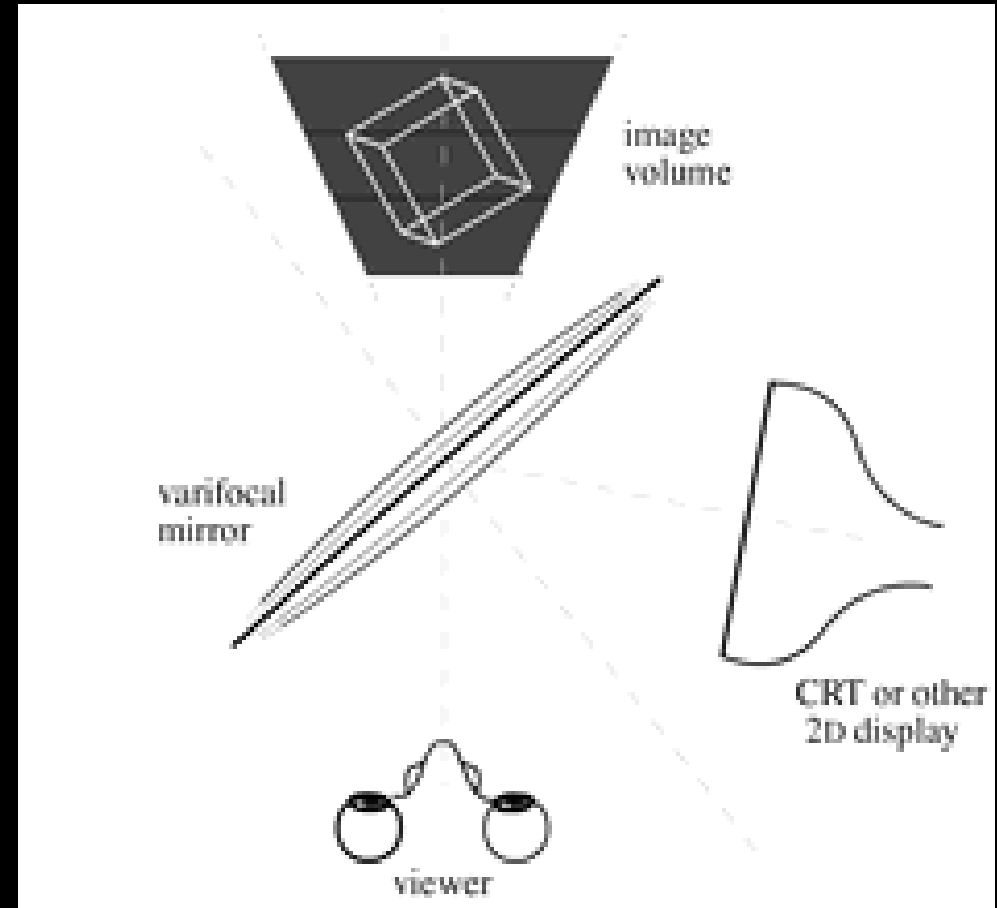
3,000 lines @ 30hz
mechanical and ultrasonic trackers
40 degree field-of-view





1967 – Traub's Varifocal Mirror

Aluminum-coated mylar mirror that vibrated at different frequencies to change the focal length.



1979 - Chris Schmandt (MIT)

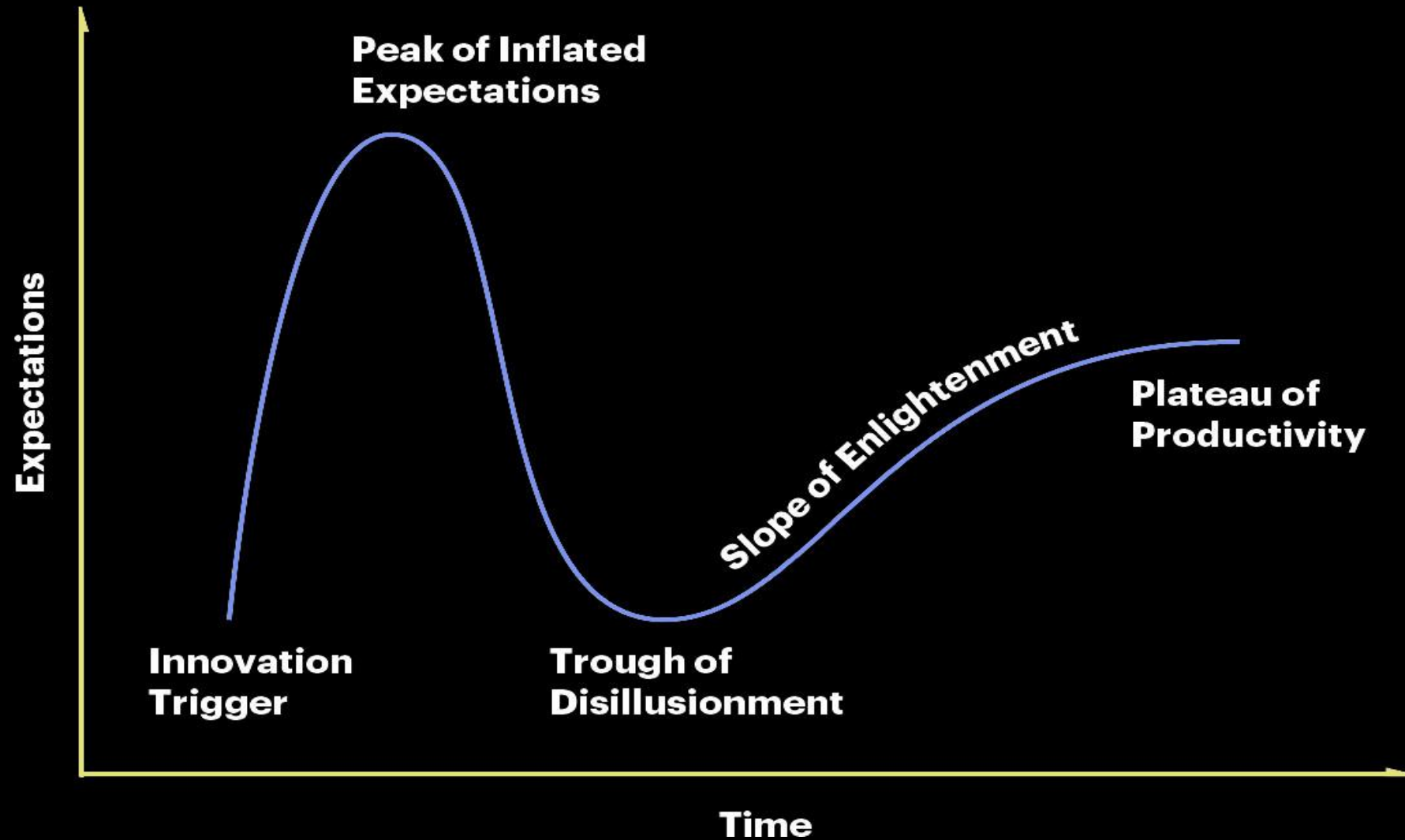


1970s - Stereoscopic Shutter Glasses

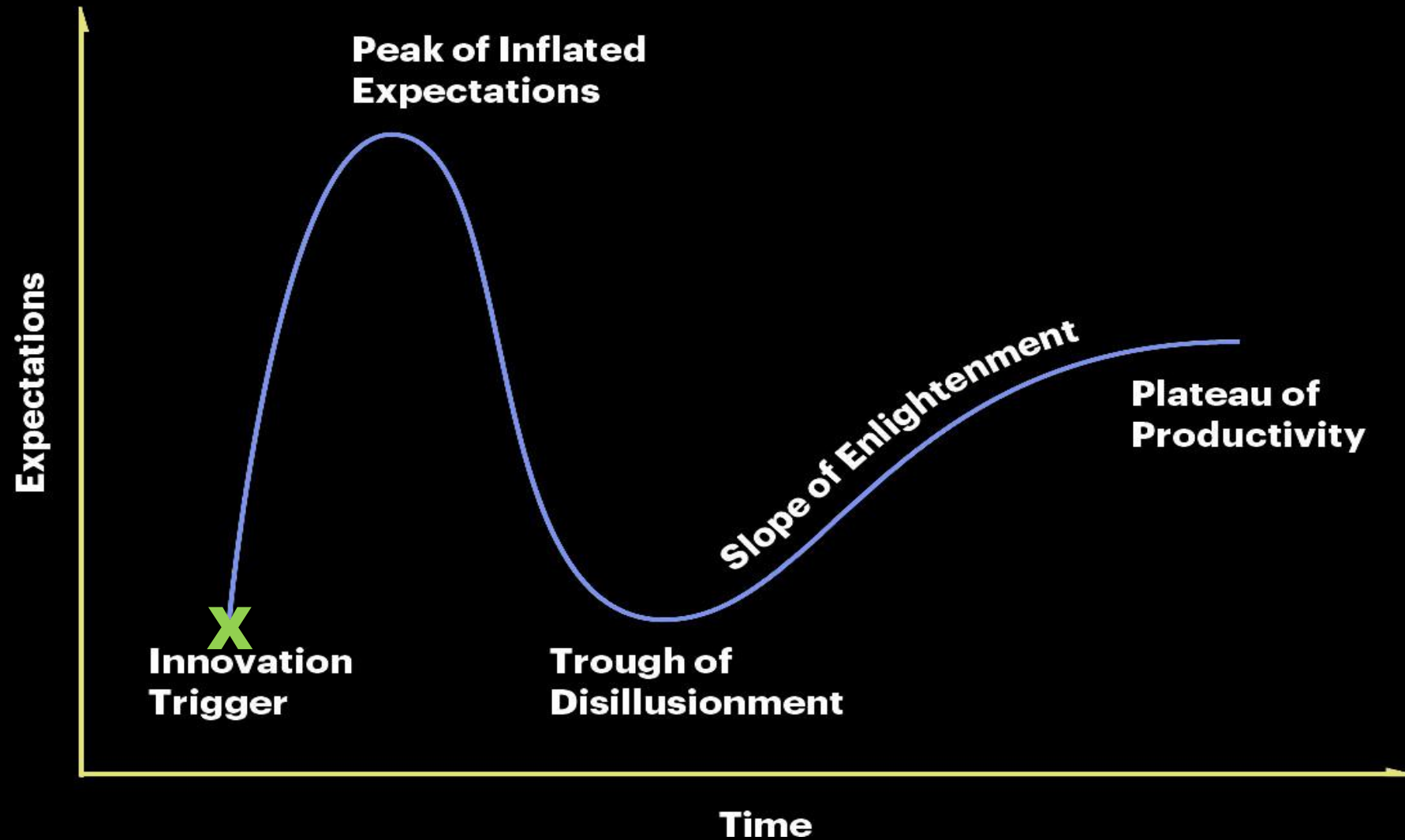
- Active (time-multiplexed) stereoscopic displays
- 1970s – PLZT Ceramic Shutters
- 1985 - Commercial LC shutter displays



Gartner's Hype Cycle for Emerging Technologies

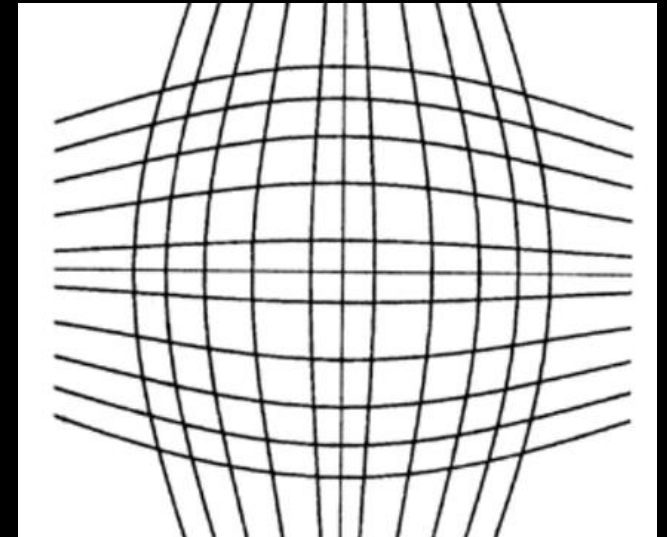


VR Hype Cycle – 1980s

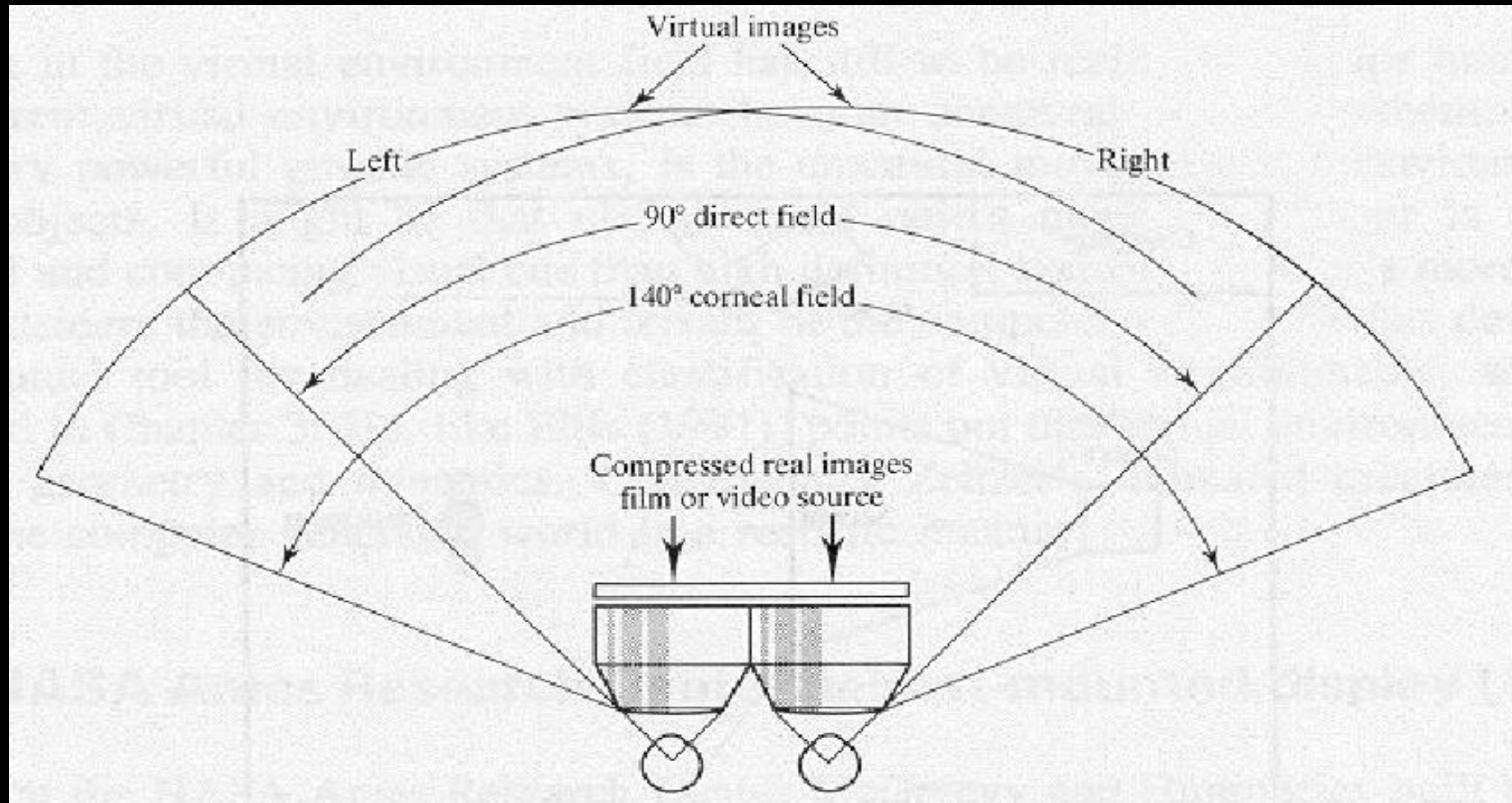


1979 - LEEP Optics

- Eric Howlett, Pop-Optix Labs 1979
- Large Expanse, Extra Perspective (LEEP)
- Originally for stereoscopic still photo viewing
- Lenses correct for intentional pin-cushion camera distortion
- Later used in head-mounted displays



1979 - LEEP Optics



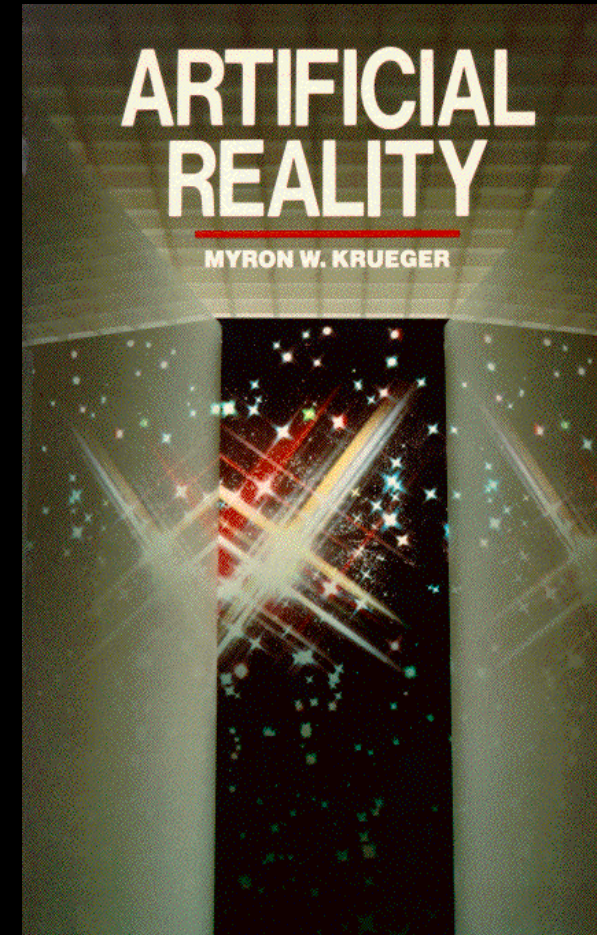
1985 – NASA Ames HMD

Wearable head-mounted display with wide field-of-view LEEP optics, created by McGreevy and Humphries.

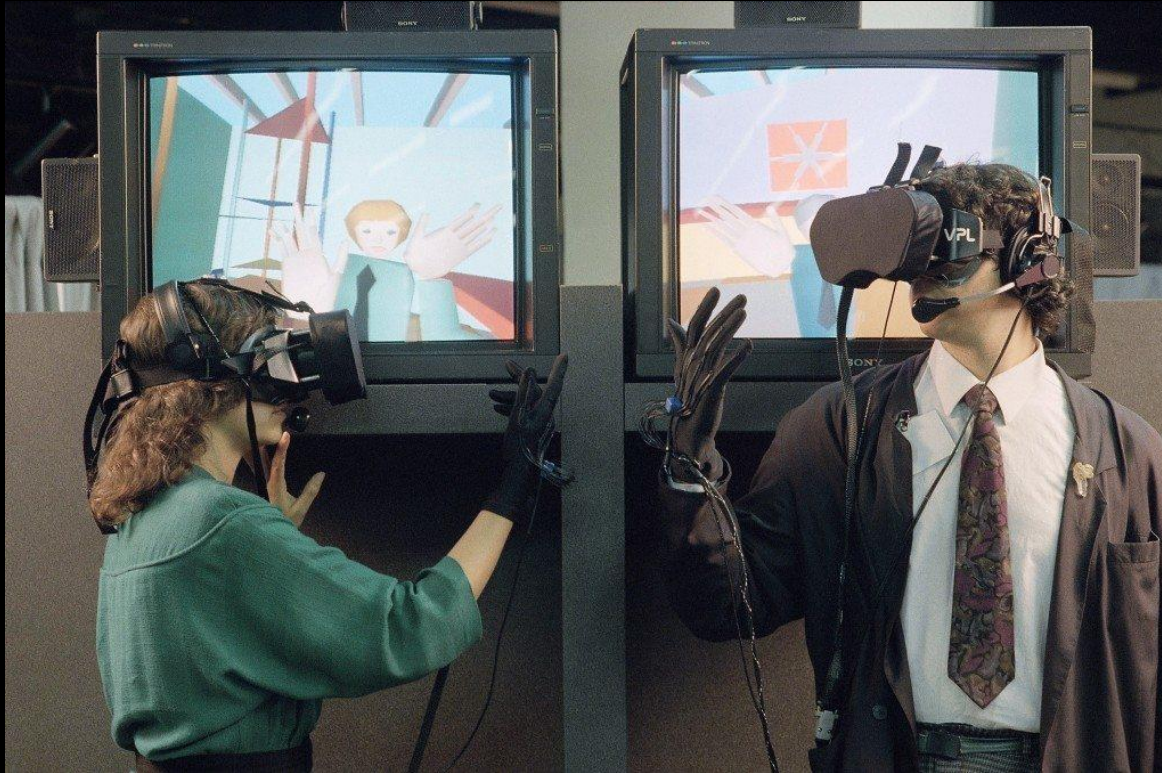


1983 - Artificial Reality (Myron Krueger)

- **Responsive Environment** is an environment where human behavior is perceived by a computer which interprets what it observes and responds through intelligent visual and auditory displays
- Contained many of the ideas that define:
 - Virtual Reality
 - Context Aware Computing



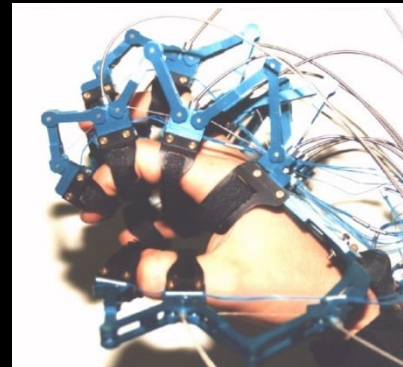
1985 – VPL Founded



Founded by Jaron Lanier, VPL was one of the first companies to sell VR products, including the Data Glove and the EyePhone HMD.

1980s – Data Gloves

- Light, electrical or metal detectors compute “bend”
- Electrical sensors detect pinches
- Force feedback mechanical linkages



1989 – VPL Eyephone HMD

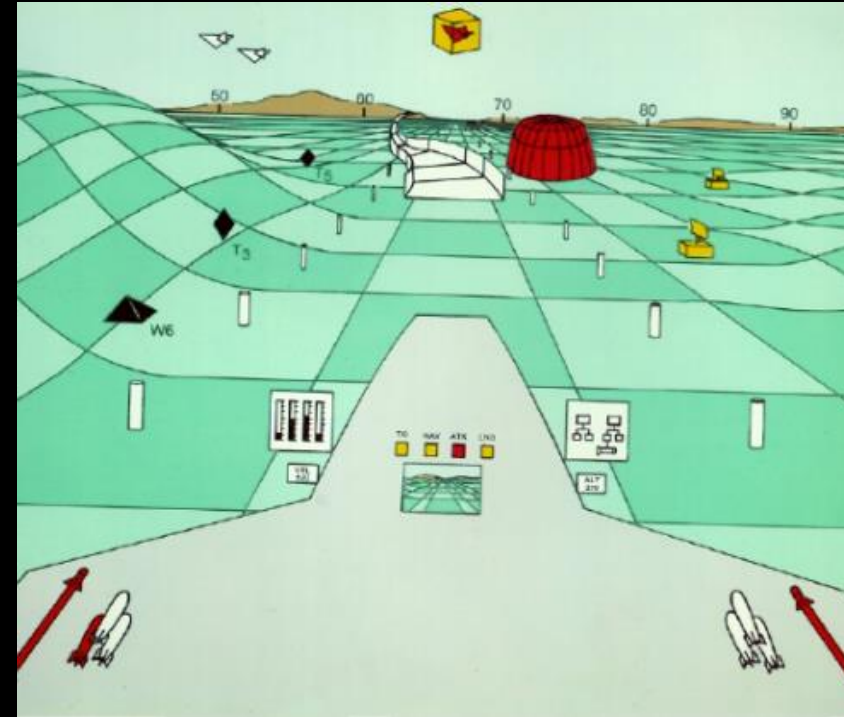
- Resolution: 184x138 / eye
- FOV: 80 degrees / eye
- Optics: LEEP
- Price: \$9,400



1980s - Virtual Environment Workstation (NASA)

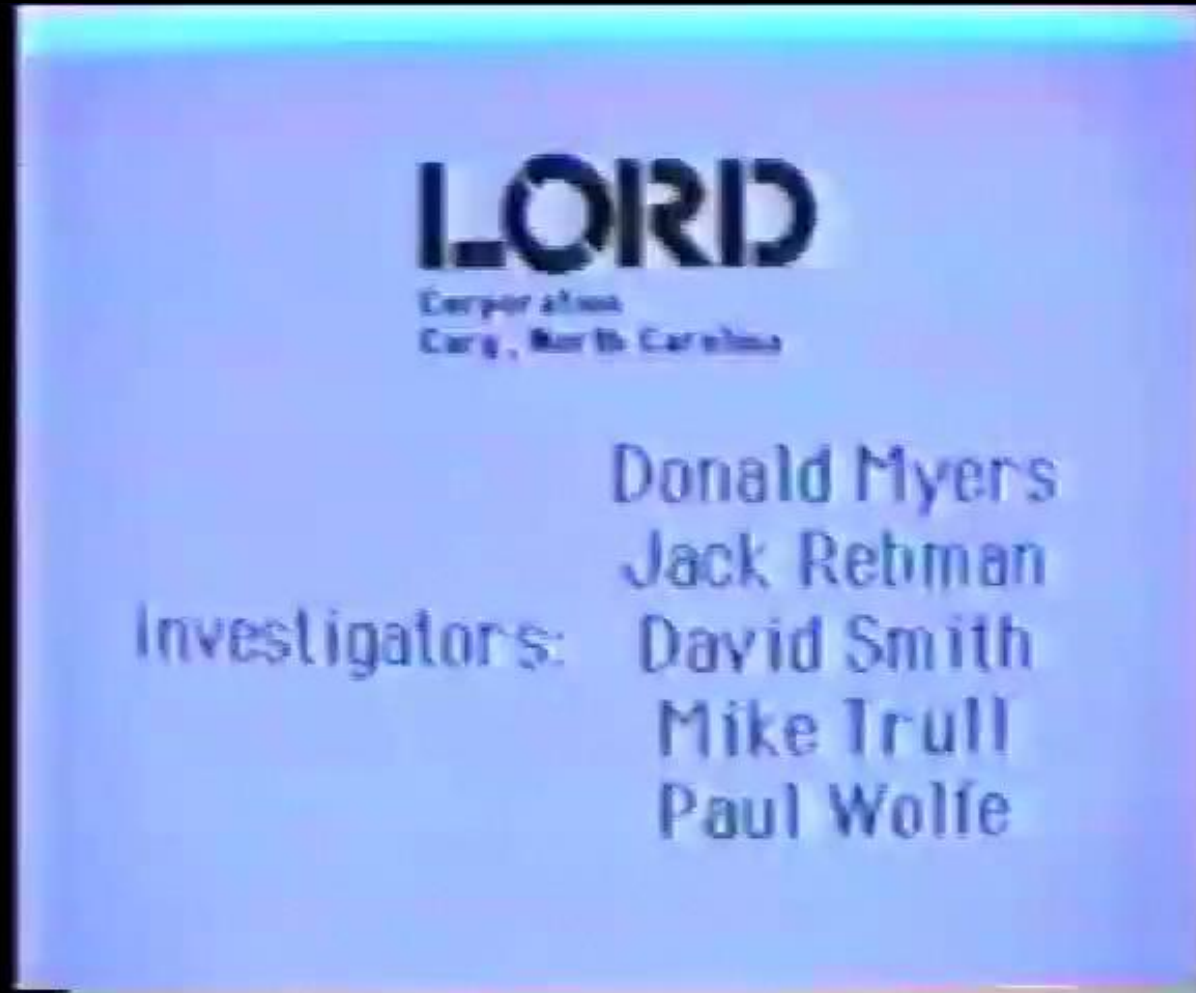


1986 – Super Cockpit (Air Force)



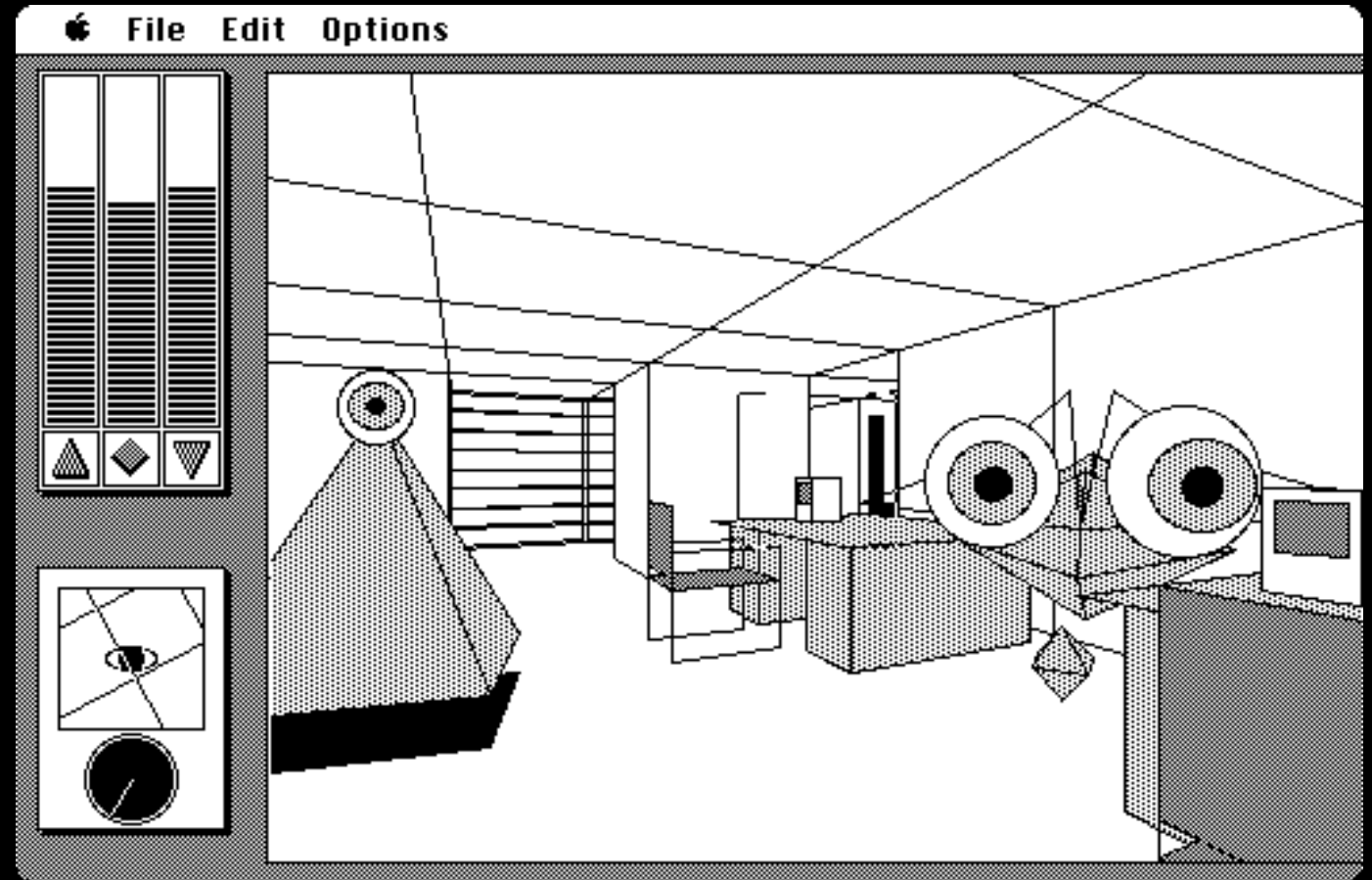
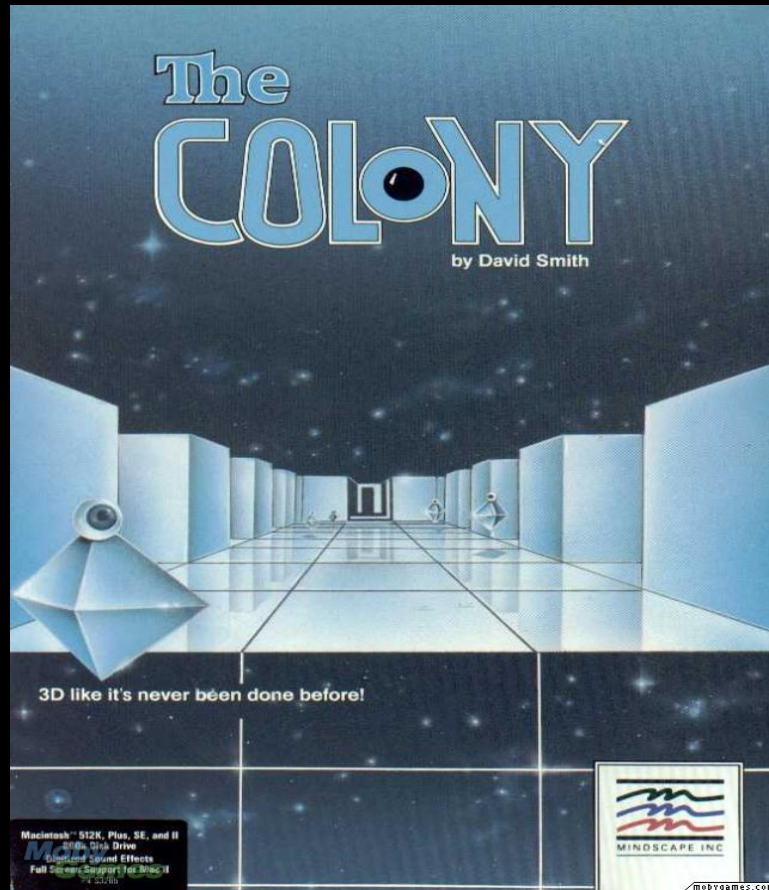
Developed by Tom Furness at the Wright Patterson Air Force Base. The helmet's tracking system, voice-actuated controls, and sensors enabled the pilot to control the aircraft with gestures, voice, and eye movements.

1987 – Robotic Teleoperation



video provided by David A. Smith

1987 – The Colony



First real-time 3D adventure game developed by David A. Smith.

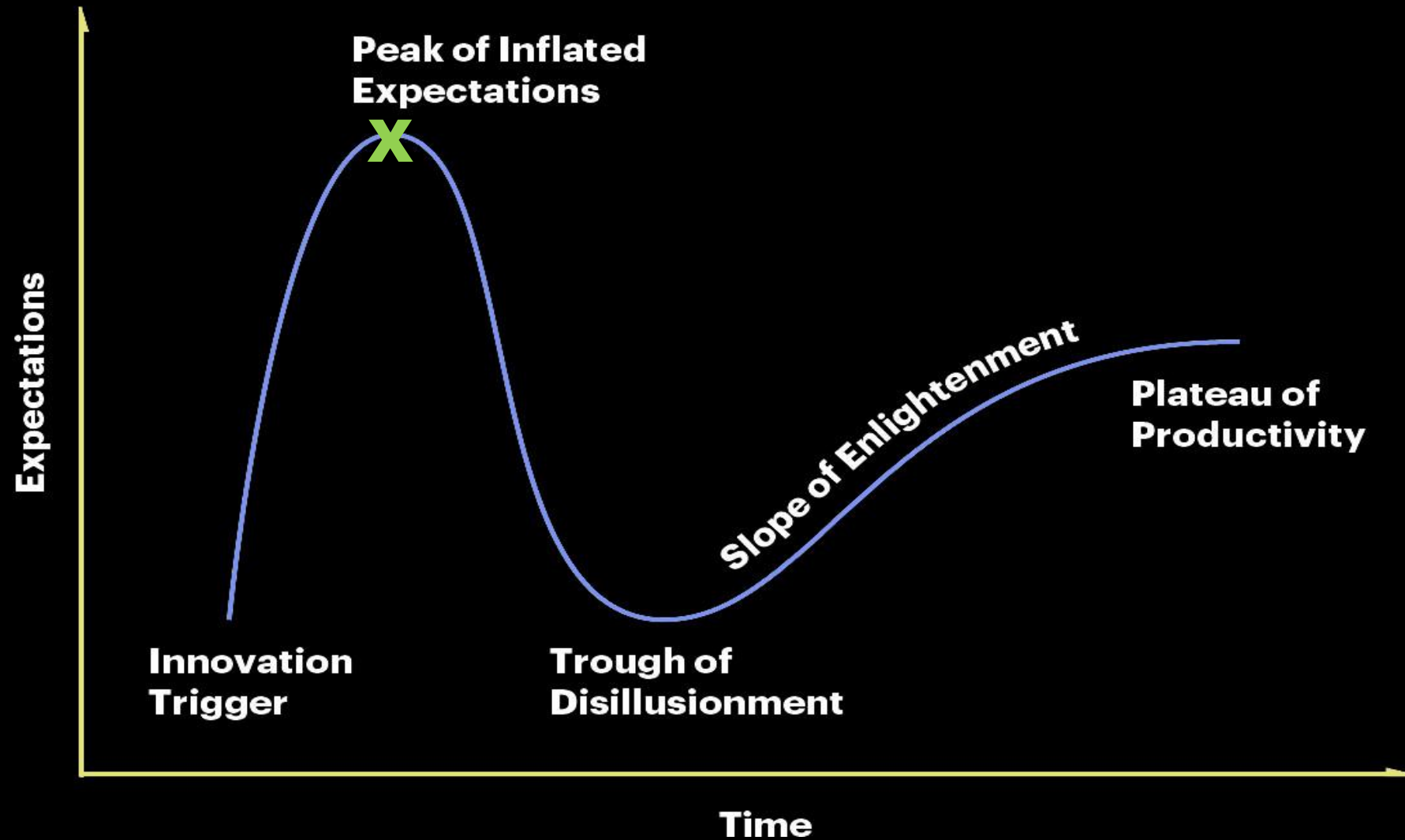
VR Gets Public Attention



Scientific American, 1987



VR Hype Cycle – early 1990s



VR Research Events

- 1987 - VR in Scientific American
- 1990 - SIGGRAPH Panel Session
- 1991 - International Conference on Artificial Reality and Telexistence (ICAT)
- 1995 - IEEE Virtual Reality Annual International Symposium (VRAIS)
- 1995 – Beginning of Clinical VR
- 1998 – DisneyQuest opens
- 1999 – VRAIS replaced by IEEE VR conference

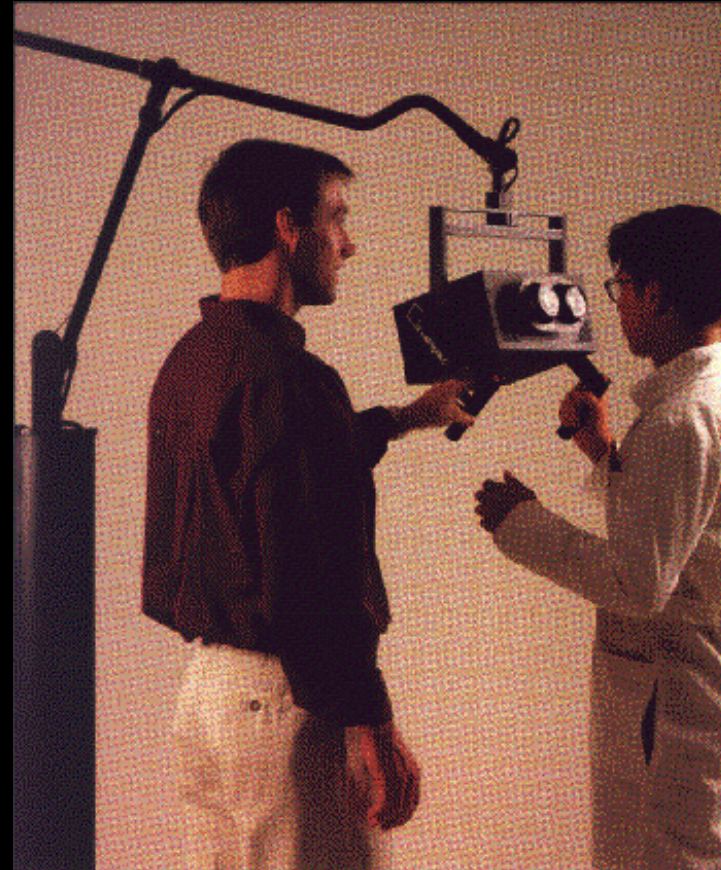
1990 – SIGGRAPH Panel

Special Session: **Hip, Hype and Hope – The Three Faces of Virtual Worlds**

Chair: Bob Jacobson, University of Washington

Panelists: John Barlow, Author and Songwriter
 Nolan Bushnell, Aaps, Inc.
 Esther Dyson, Editor, Release 1.0, Analyst
 Tom Furness, Human Interface Technology Lab
 Timothy Leary, University of Pittsburgh
 Warren Robinette, University of North Carolina
 Randall Walser, Autodesk

1990s – Fakespace Boom Display



Invented by Mark Bolas and Ian McDowall.

1992 – UNC Virtual Kitchen

Seeing and Feeling

In virtual reality (VR) experiments, people wearing special headsets are able to "see" an environment. This is especially helpful in designing new environments, whether the floor plan of a building or the layout of a warship. A UNC research project not only allows you to "see" what an environment looks like but also what it "feels" like. Hybrid reality allows users to actually feel and bump into the objects seen in the virtual environment. Researchers hope to find out if virtual environments seem more real when users cannot walk through virtual walls or solid objects, as they have been able to do in most VR environments.

UNC researchers set up a model kitchen made of styrofoam, simulating countertops, work islands, a sink and other features of a kitchen. Wearing the VR headset, a user sees a synthetic visual kitchen, which replicates, with half-inch accuracy, an actual kitchen. However, the visual model and the styrofoam model have been carefully aligned so that when the user reaches out to touch something such as a countertop corner, the corner in the styrofoam model is where the visual information indicates it will be.

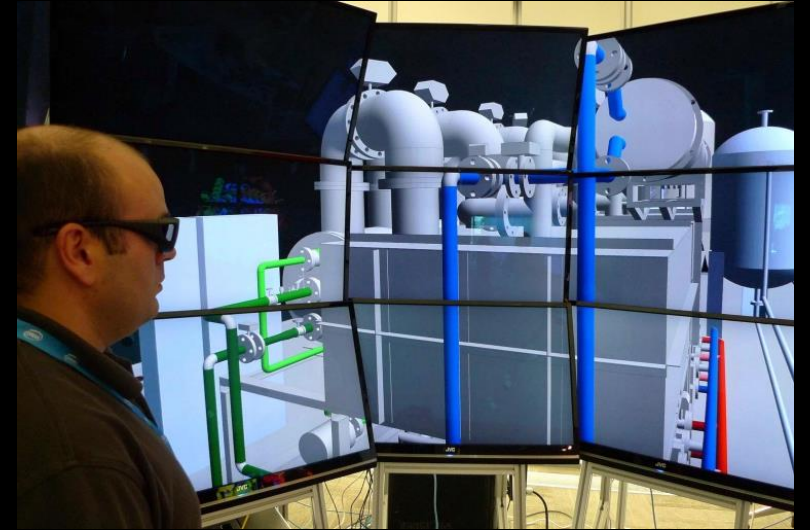


A researcher moves around the styrofoam model kitchen (above) while seeing the synthetic visual model (above right) through the headset. Both models are based on an actual kitchen (below right). Photos by Larry Ketchum



Passive haptics introduced to enhance virtual reality with physical touch.

1992 - CAVE



The CAVE Automatic Virtual Environment was a multi-screen immersive stereoscopic projection system developed by Carolina Cruz Neira, Dan Sandin, and Tom DeFanti (EVL, UIC).

1995 – Responsive Workbench



W. Kruger, C. Bohn, B. Frohlich, H. Schuth, W. Strauss and G. Wesche, The Responsive Workbench: a virtual work environment, *Computer*, 28(7): 42-48, 1995.

1995 - VRAIS

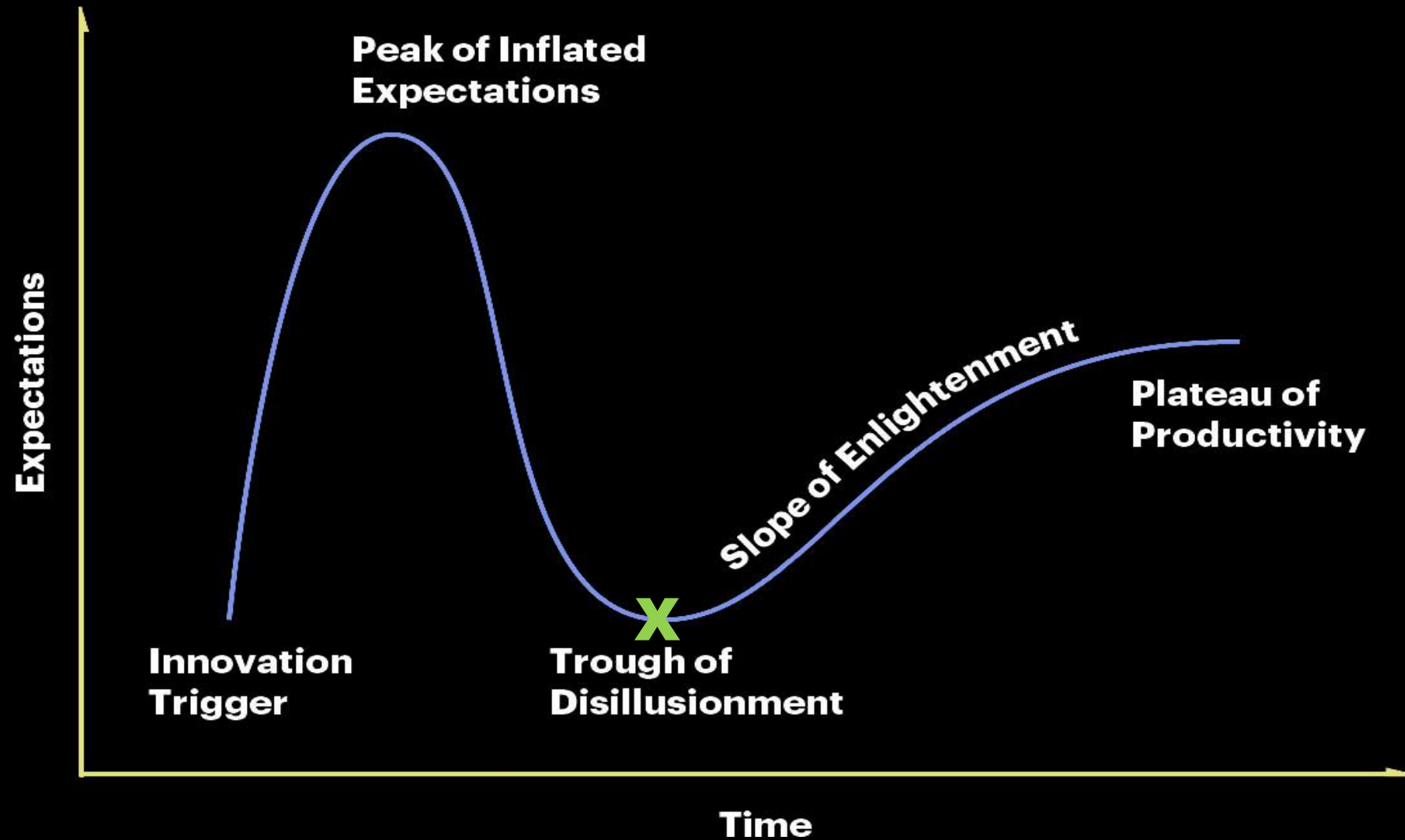
- First IEEE Virtual Reality Annual International Symposium (now IEEE VR)
- First hosted as a smaller symposium in 1993 Seattle
- Combined with a subset of visualization researchers who had started working on VR from a workshop at IEEE Vis 1993.

1995 – Clinical VR



Effectiveness of computer-generated (VR) graded exposure in the treatment of acrophobia in *American Journal of Psychiatry*.

VR Hype Cycle – late 1990s



Commercial Failures

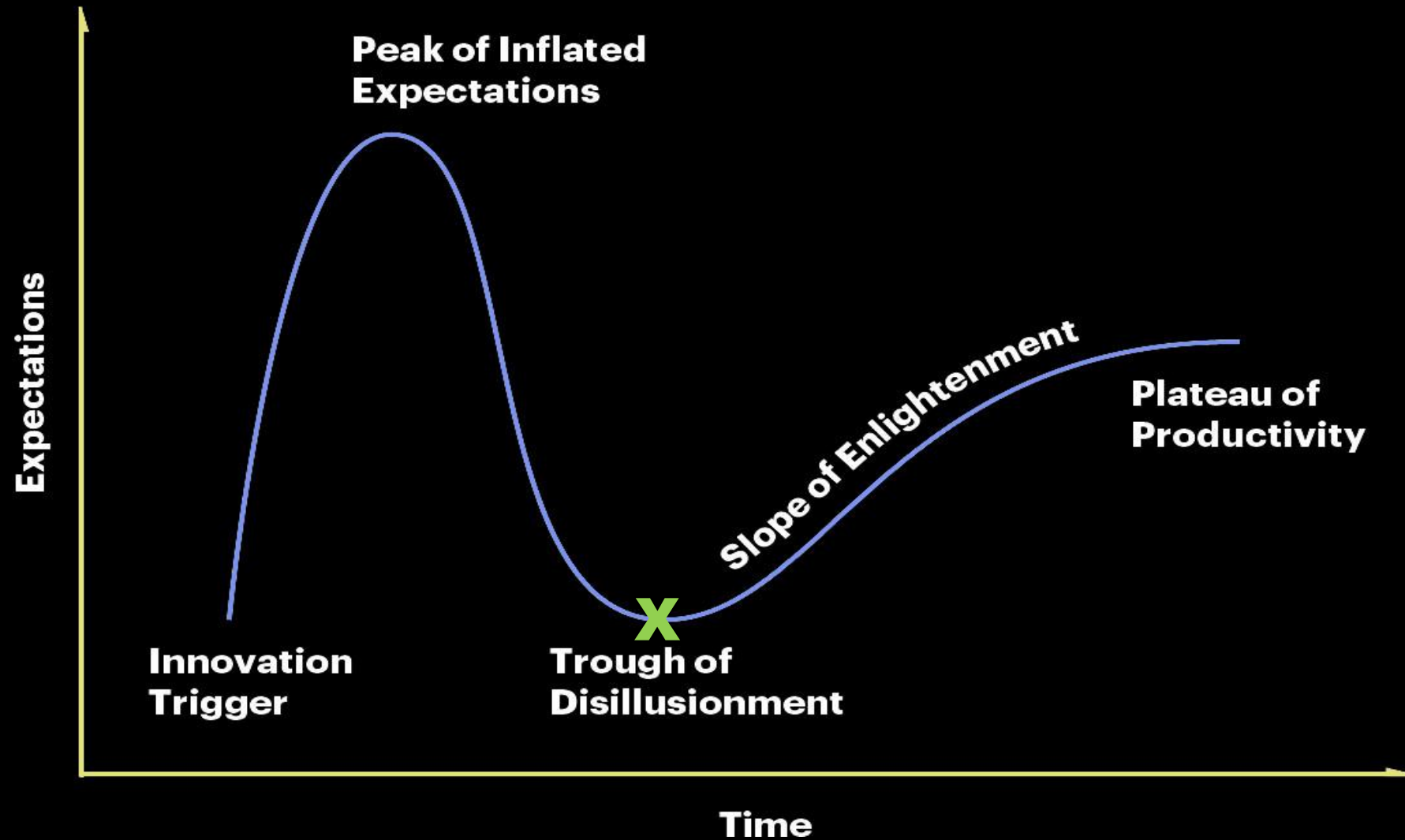


Sega VR, 1993



Nintendo Virtual Boy, 1995

VR Hype Cycle – 2000-2010



Head-Mounted Displays, circa 2010



eMagin Z800

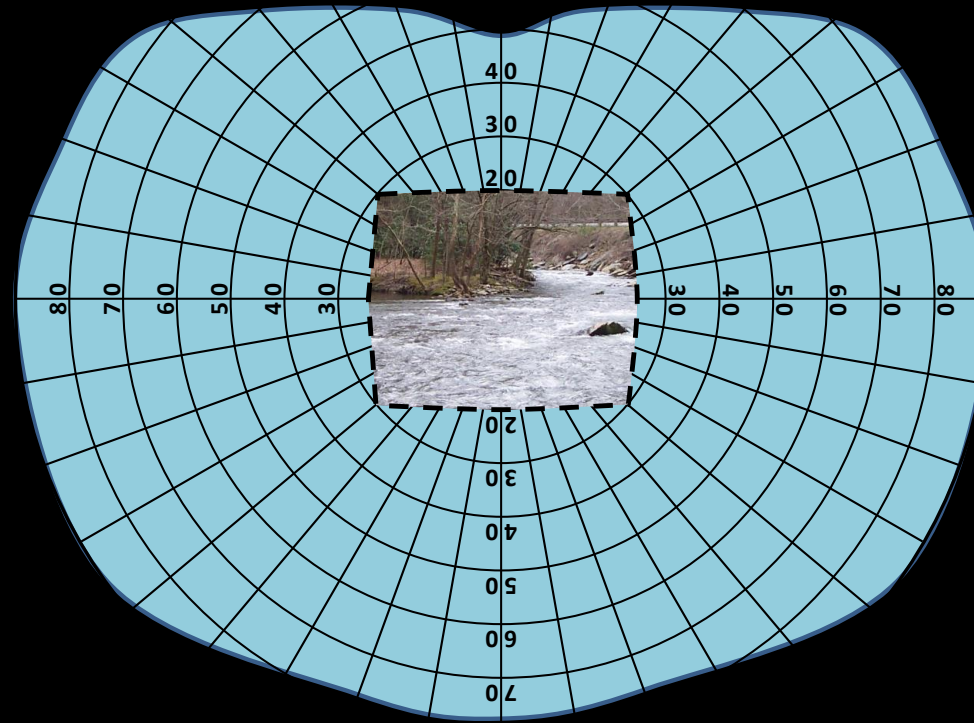


NVIS nVisor SX111

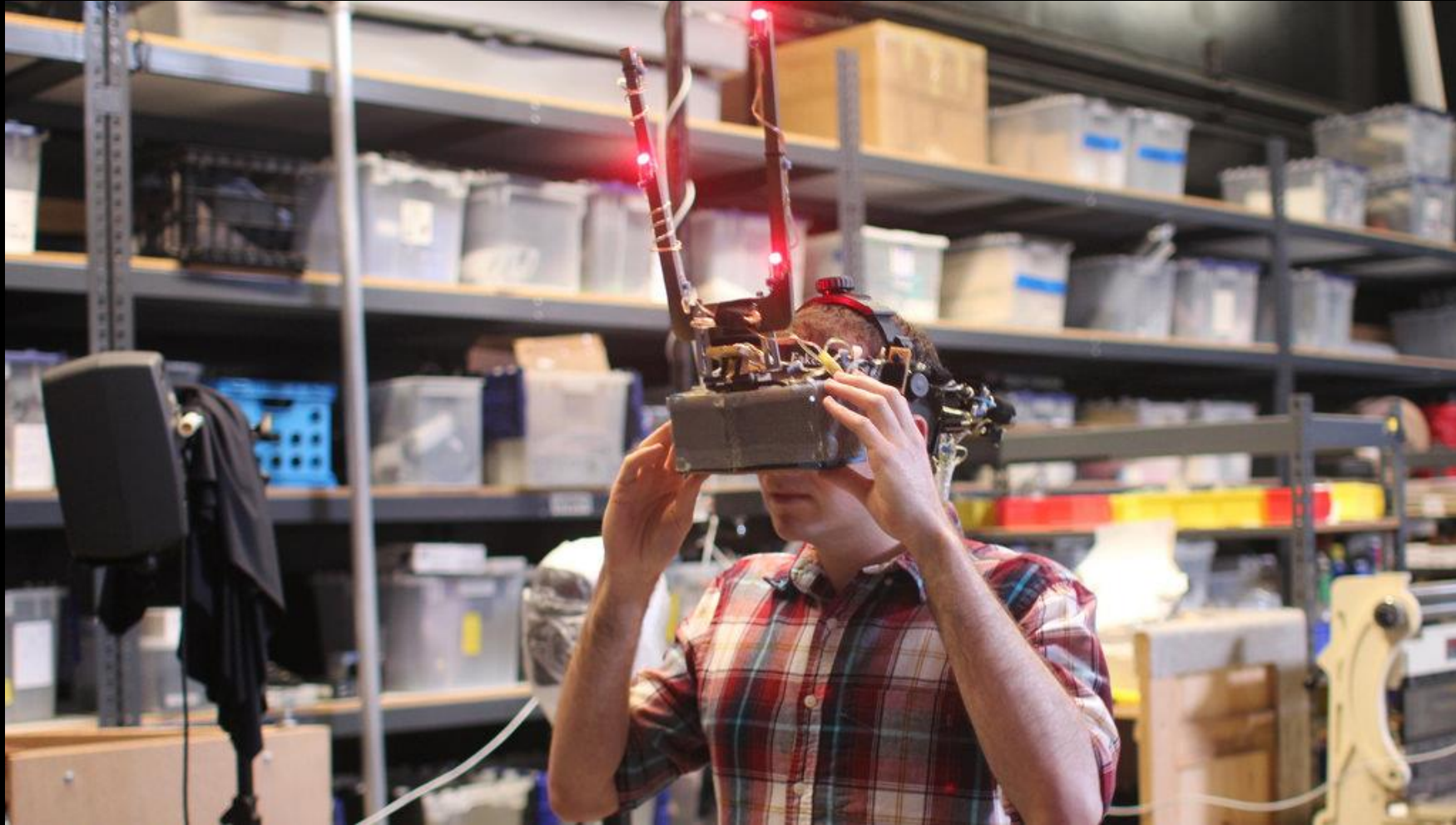
Head-Mounted Displays, circa 2010

Model	Field of View	Price	Dollars / Degree
SX100	100	\$65,000	650
xSight	123°	\$39,000	317
Wide 5	150°	\$45,000	300
SX111	111°	\$27,000	243
Z800	40°	\$1,800	45
HMZ-T1	45°	\$800	18

Field-of-View (60 degrees)



2008 – Fakespace Wide 5



Invented by Mark Bolas and Ian McDowall.

2011 – LMEyes (Lockheed Martin)



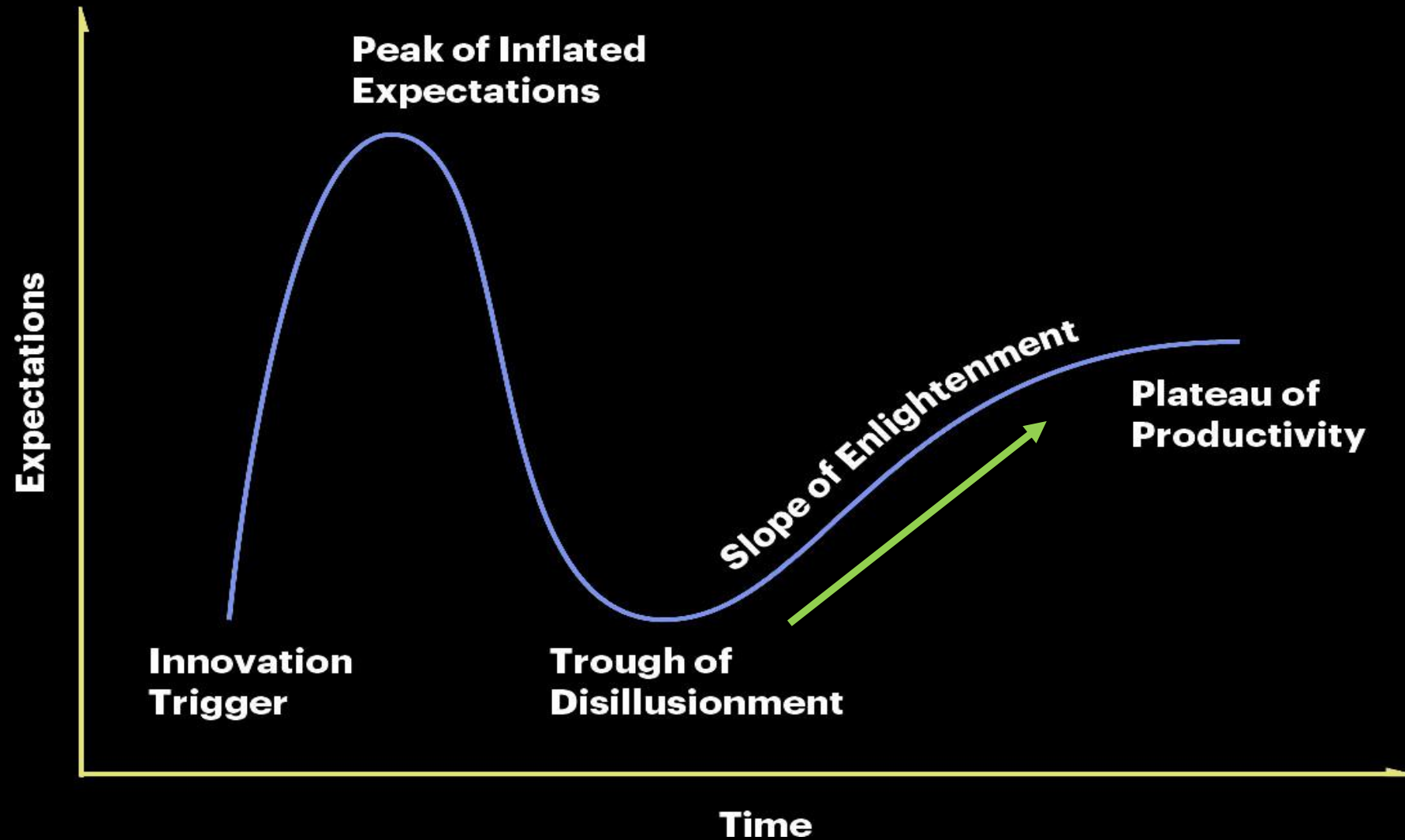
Field-of-View (140 degrees)



Head-Mounted Displays, circa 2010

Model	Field of View	Price	Dollars / Degree
SX100	100	\$65,000	650
xSight	123°	\$39,000	317
Wide 5	150°	\$45,000	300
SX111	111°	\$27,000	243
Z800	40°	\$1,800	45
HMZ-T1	45°	\$800	18

Climbing the Slope of Enlightenment



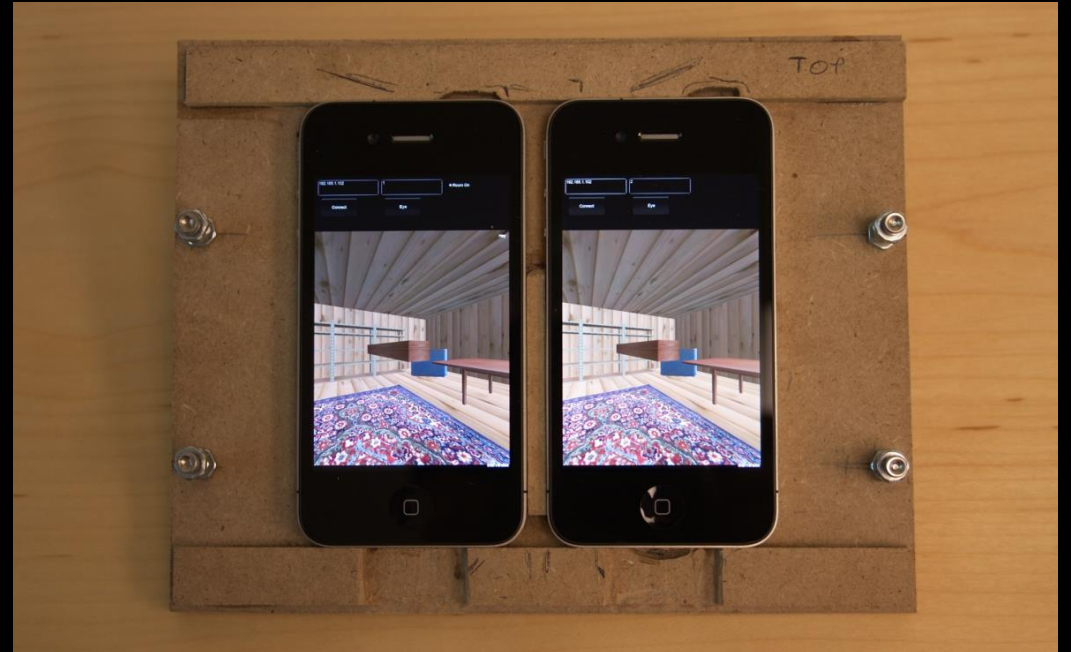
USC ICT MxR Lab

- University research institute
- Supported by the U.S. Army
- MxR Lab directed by Mark Bolas
- Introduced low cost, open-source VR prototypes from 2010-2013



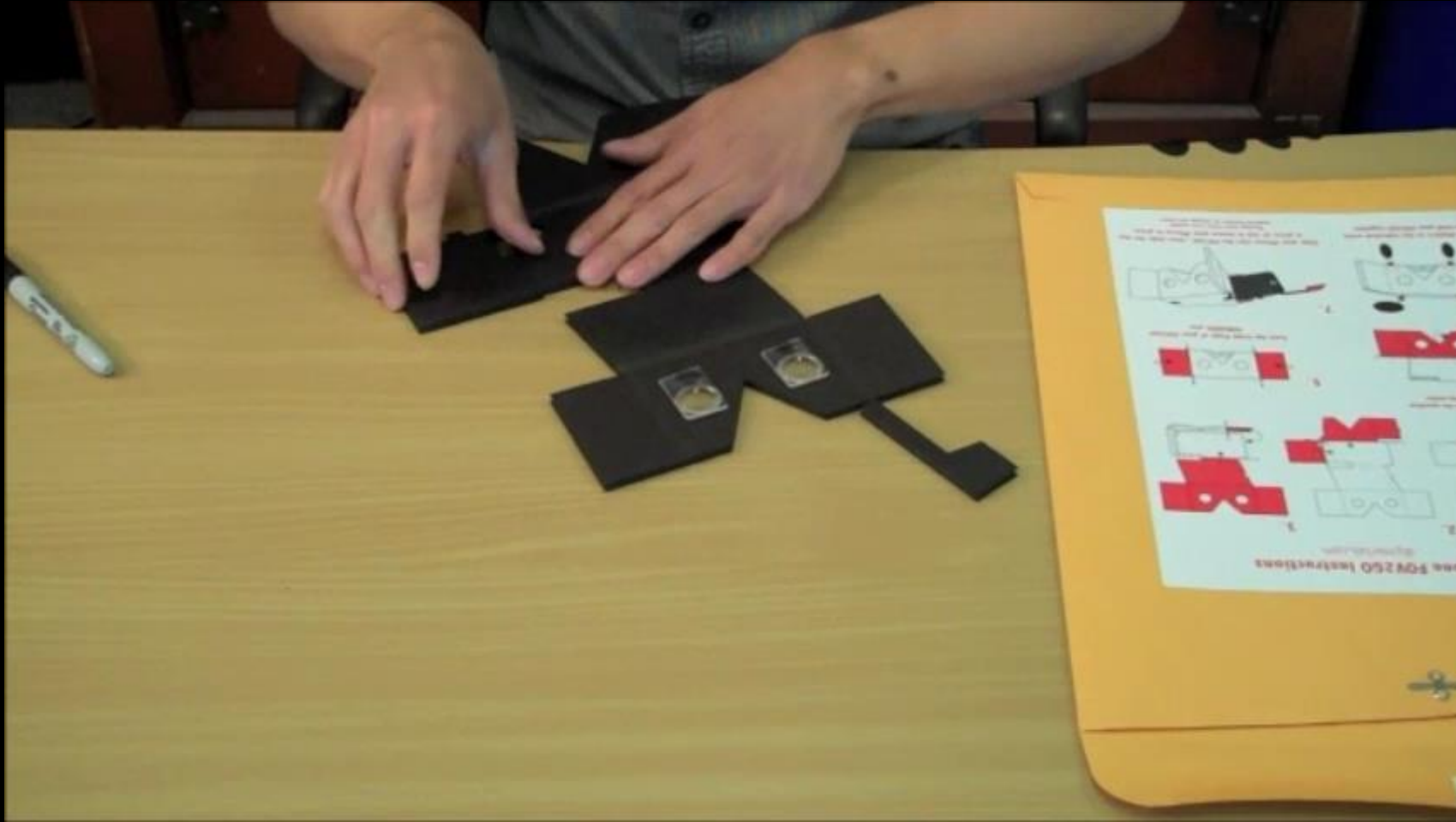
USC Institute for
Creative Technologies

2011 – LEEP Smartphone Display



J. Logan Olson, David Krum, Evan Suma, and Mark Bolas. A design for a smartphone-based head mounted display, IEEE VR 2011.

2012 – FOV2GO



David Krum, Evan Suma, and Mark Bolas. Virtual Reality to Go: A USC ICT Mixed Reality Lab Demonstration, IEEE VR 2012.

2011 – Low-Cost Headset Prototyping



Palmer Luckey Joins the MxR Lab



“Frankendisplays”

2012 – 3D Printed VR Displays




Socket HMD



Phone & Tablet Viewers

2012 – Palmer Luckey Launches Oculus Rift on Kickstarter

Funded! This project successfully raised its funding goal on Sep 1, 2012.



A black Oculus Rift Developer Kit headset with a blue Oculus logo on the side. A red banner in the top left corner reads "2012 BEST OF E3 NOMINEE". A "PLAY" button is overlaid on the headset.

9,522 backers
\$2,437,429 pledged of \$250,000 goal
0 seconds to go

Funding period
Aug 1, 2012 - Sep 1, 2012 (30 days)

Project by
Oculus
Long Beach, CA
[Contact me](#)

[First created](#) · 24 backed
[Has not connected Facebook](#)
Website: oculusvr.com
[See full bio](#)

[Share](#) 7,289 [Tweet](#) [Embed](#) ★

Developer kit for the Oculus Rift - the first truly immersive virtual reality headset for video games.



2014 – Facebook Acquires Oculus for \$2 Billion



2014 – Google Cardboard

GOOGLE CARDBOARD

Experience virtual reality in a simple,
fun, and affordable way.



2016 – Commercial VR Headsets



2017 – Mixed Reality Headsets

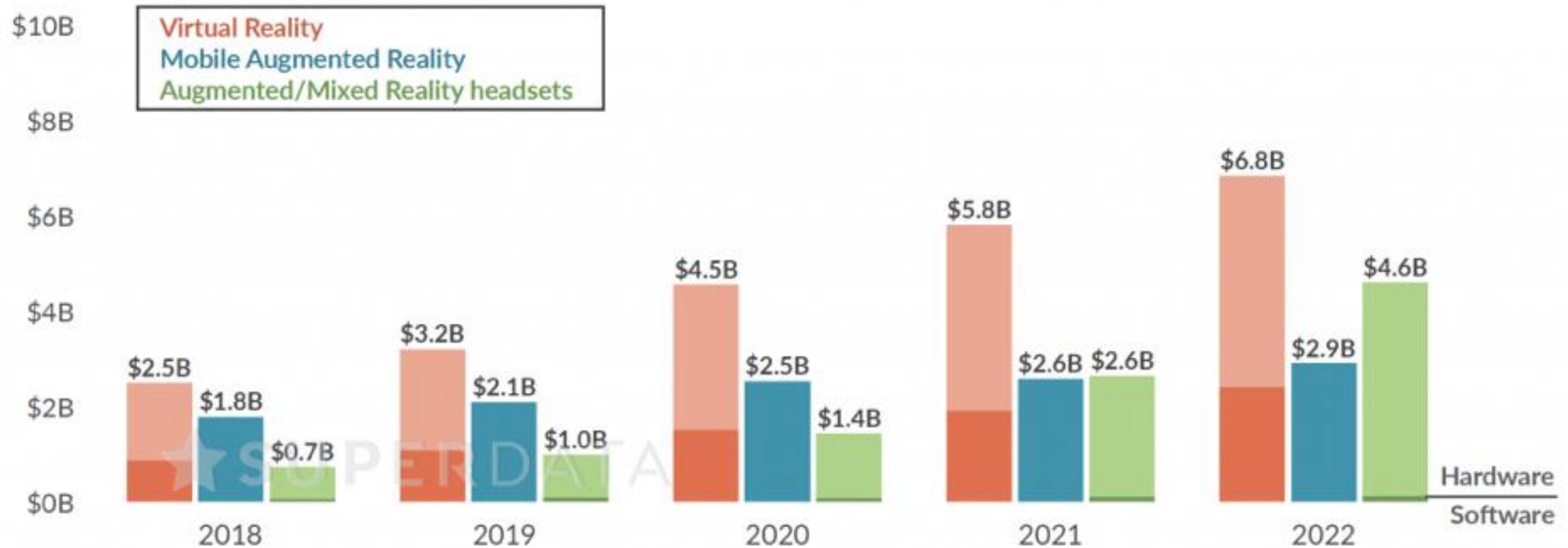


2019 – Portable/Untethered VR Headsets



The Immersive Market

Hardware and consumer software revenue: 2018-2022
Billions of USD, worldwide





Virtual Reality is More Than Just a Headset

Photo Credit: Ars Technica

Conclusion

- Virtual reality technology is maturing rapidly
- Software/content has not kept pace with hardware sales
- Not enough attention given to VR user interfaces
- Many opportunities for graduates with VR UI experience!