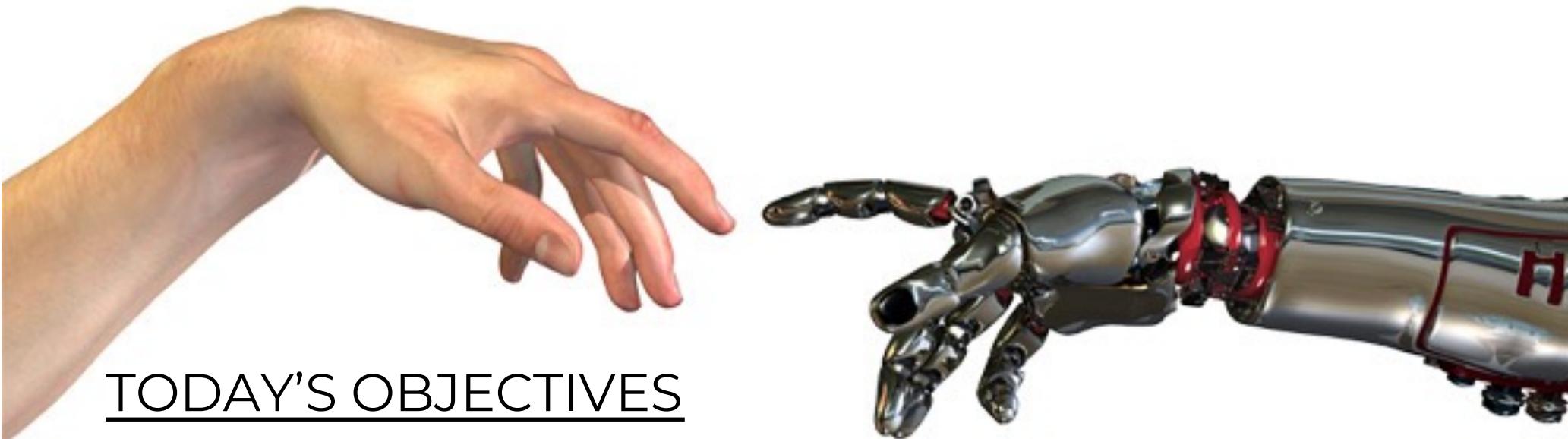


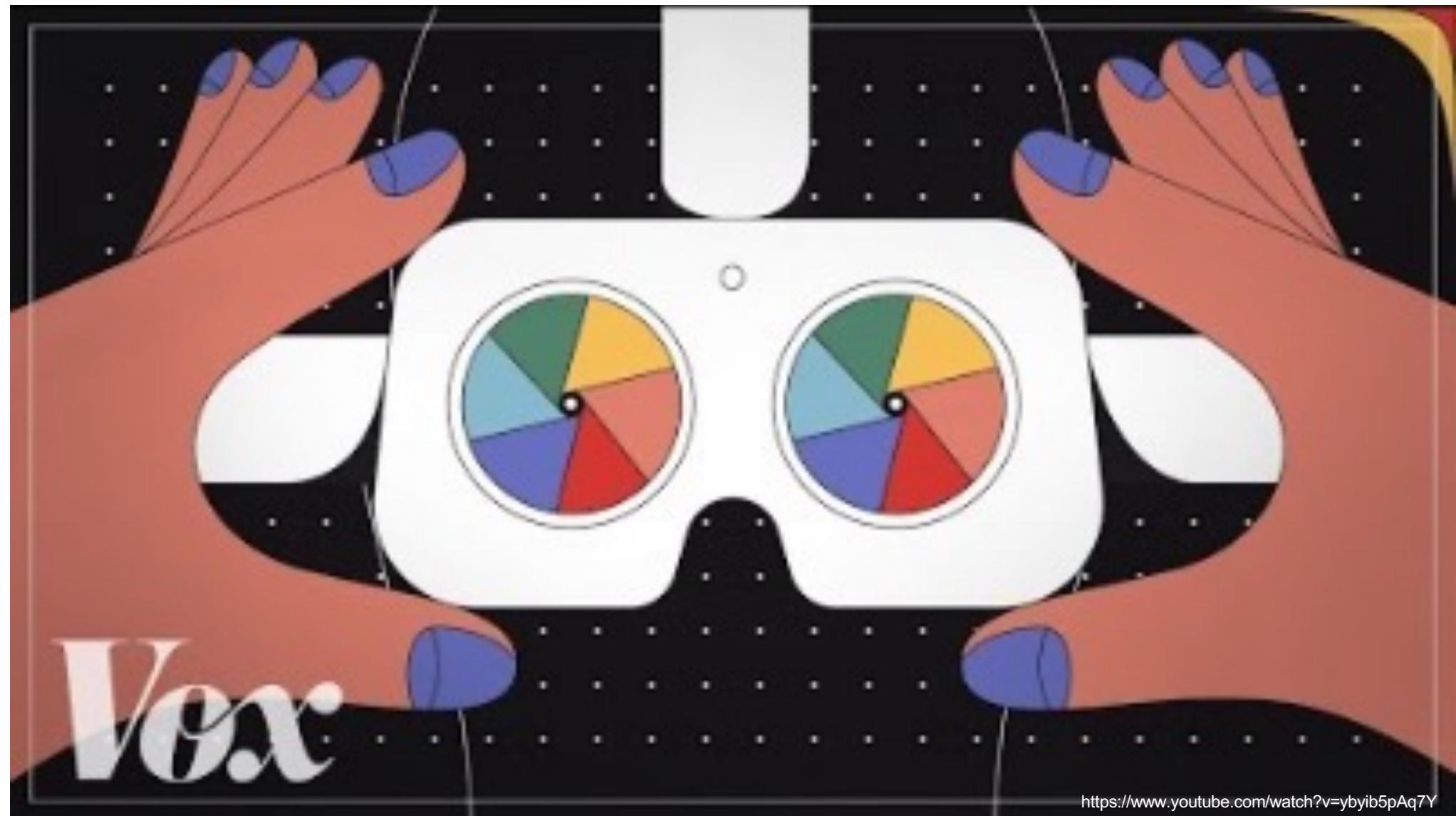
Human-Computer Interaction

Virtual Reality Design Guidelines Part I



TODAY'S OBJECTIVES

- 1.) History of VR
- 2.) Design principles



<https://www.youtube.com/watch?v=ybyib5pAq7Y>

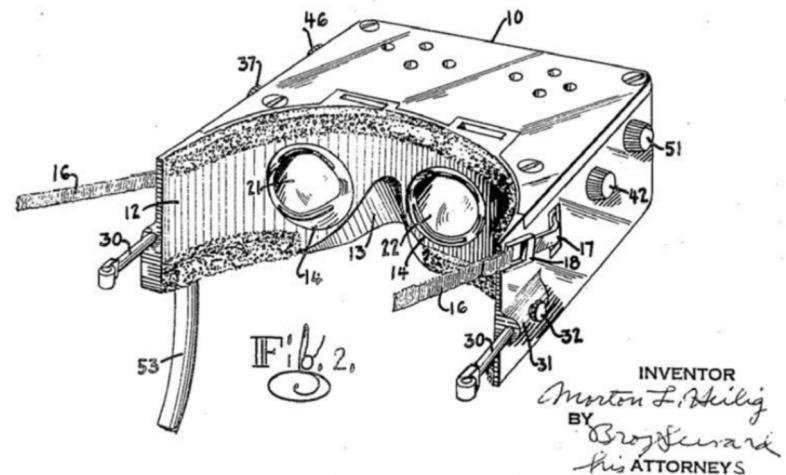
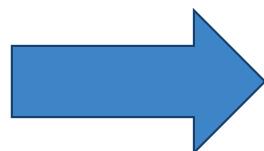
What is Virtual Reality (VR)?

- Webster Dictionary define it as:
 - **Virtual** - being such in essence or effect though not formally recognized or admitted
 - **Reality** - the quality or state of being real
- As a whole Virtual Reality is:
 - Computer-generated environment
 - Digital environment experienced or interacted with as if the environment is real

History of VR



1860 - A Brewster Stereoscope

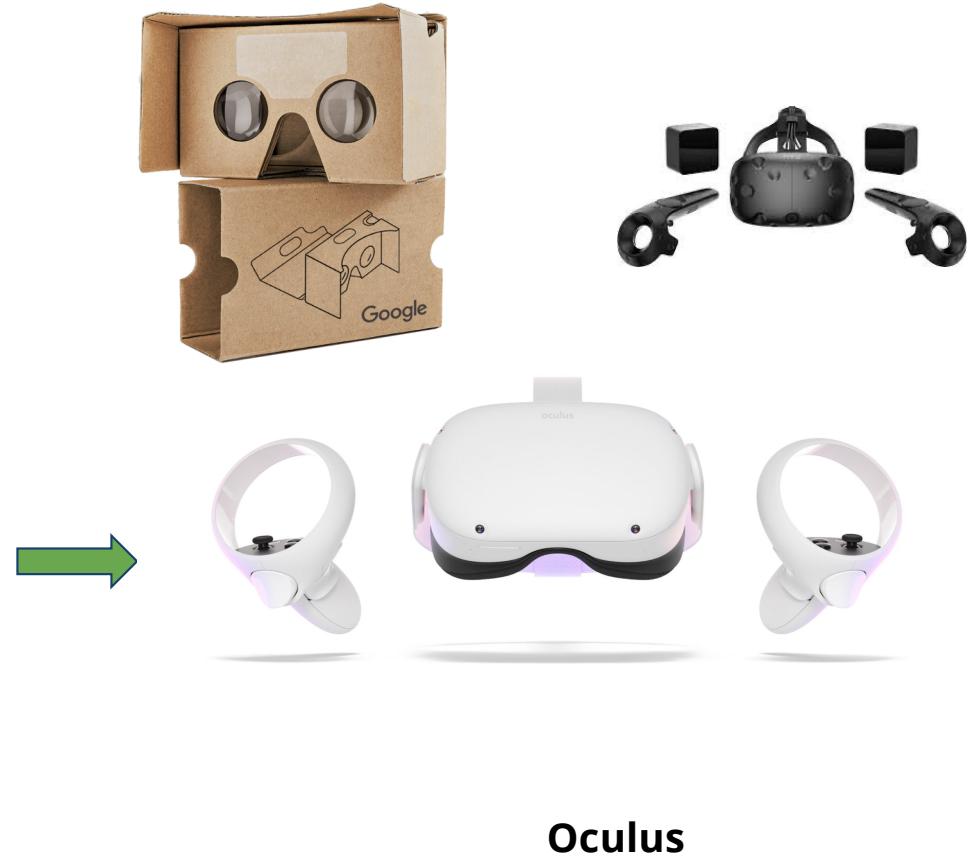


1960 - Heilig's Stereoscope Television Apparatus Patent

Mills, Virginia. "180 Years of 3D: Royal Society." *180 Years of 3D | Royal Society*, 14 Aug. 2018, royalsociety.org/blog/2018/08/180-years-of-3d/

"The History of VR." *Virtual Reality & Journalism*, 12 Dec. 2018, virtualreality.web.illinois.edu/history-of-vr/

Present VR

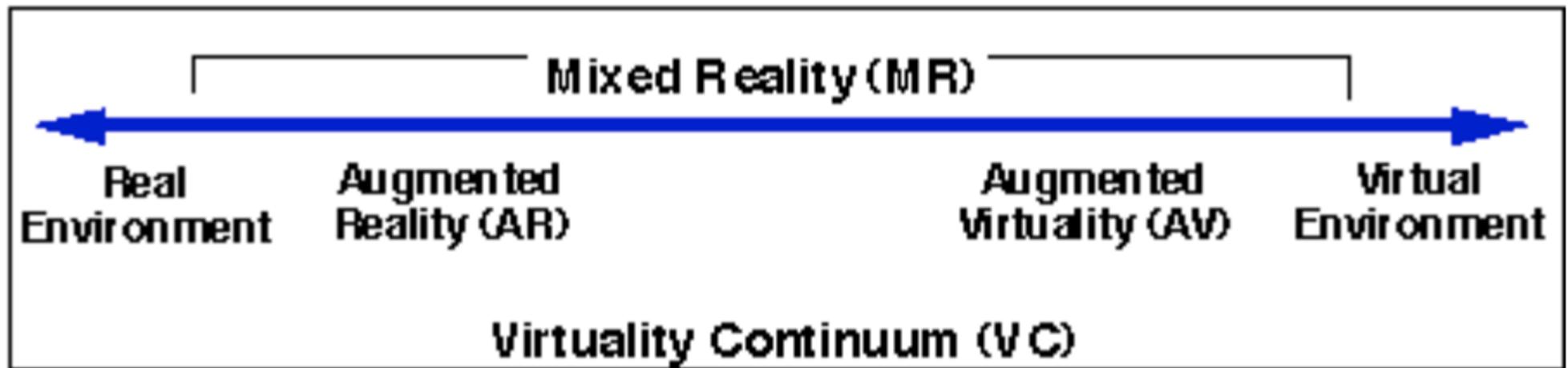


Oculus

Chaykowski, Kathleen. "Mark Zuckerberg Has A Plan To Bring Facebook Users Into Virtual Reality." *Forbes*, Forbes Magazine, 24 Feb. 2016, www.forbes.com/sites/kathleenchaykowski/2016/02/24/mark-zuckerberg-has-a-plan-to-make-virtual-reality-social/?sh=5cda075f31f1

Hardawar, Devindra. "Oculus Quest 2 Delivers Standalone VR with Sharper 90Hz Screens for \$299." *Engadget*, 17 Sept. 2020, www.engadget.com/oculus-quest-2-vr-299-171715370.html

Virtual Continuum



Milgram, P., & Kishino, F. (1994). A Taxonomy of Mixed Reality Visual Displays..

Virtual Continuum Contd.



Video Game

VR Games



The Void



Magic Leap

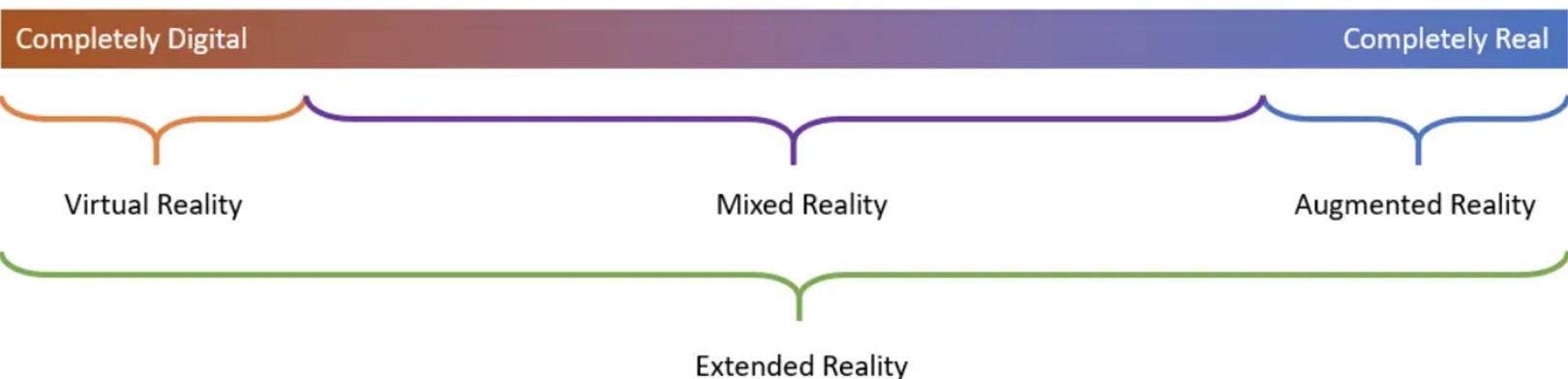
HoloLens



Instagram Filters

Pokemon Go

Actual Photos



17, P., & Lodola, A. (2018, November 07). Mixed reality vs augmented reality: What's the difference? - Aniwa blog. Retrieved December 08, 2020, from <https://www.aniwaa.com/blog/mixed-reality-vs-augmented-reality-whats-the-difference/>

Virtual Reality (VR) vs. Augmented Reality (AR) vs. Mixed Reality (MR)

VR	AR	MR
User is immersed in synthetic environment	User see the real world with superimposed virtual objects	AR + uses environment to hide/show information (Spatial Awareness)
HTC Vive Pro Eye™, Oculus Quest™, Google VR (Cardboard)™	Google Glass®, Vuzix Blade AR®	MagicLeap, Microsoft HoloLens 1® and HoloLens 2®
User and virtual objects co-exist in the same space		

VR UX/UI Design Principles

- Minimize Cyber Sickness
- Immersion
- Establish Familiarity
- Consistency
- Feedback
- Confirmation
- Physiological Measures
- Ergonomics
- Test Frequently

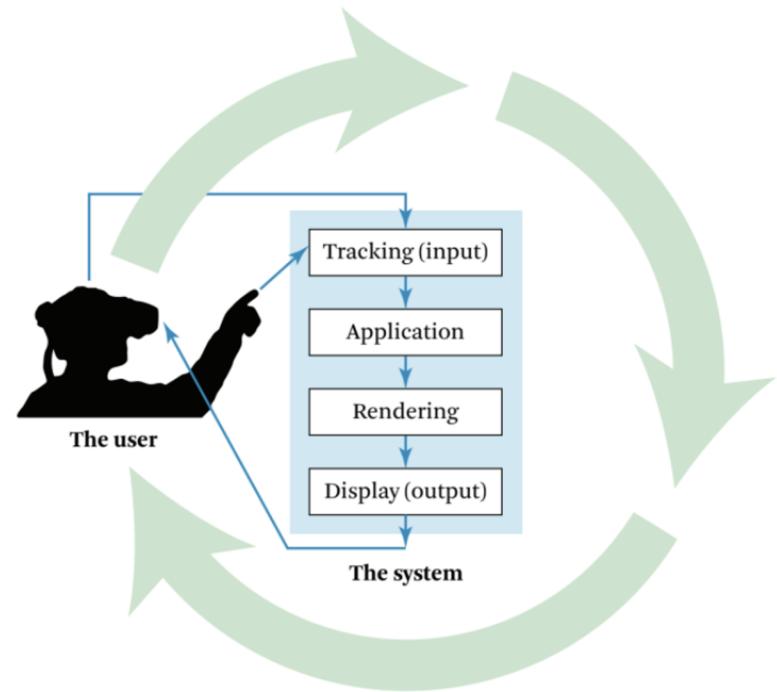


Figure 3.2: The VR Book: Human-Centered Design for Virtual Reality

Jerald, J. (2016). *The VR Book: Human-Centered Design for Virtual Reality* (Vol. 8). San Rafael, CA: Morgan & Claypool. ISBN: 978-1-97000-115-0

Minimize Cybersickness

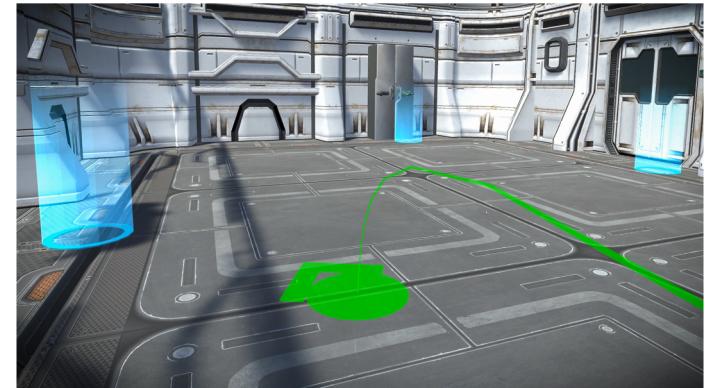
- What is Cybersickness?
 - One of the biggest challenges of VR development
 - Occurs when brain receives mismatched signals from what you see compared to physical motion experienced by the body is experiencing
 - This mismatch causes nausea known as Cybersickness



Has a virtual reality session ever left you feeling woozy? Cybersickness can leave you feeling nauseous and dizzy, just like seasickness or carsickness. Photo: Shutterstock.

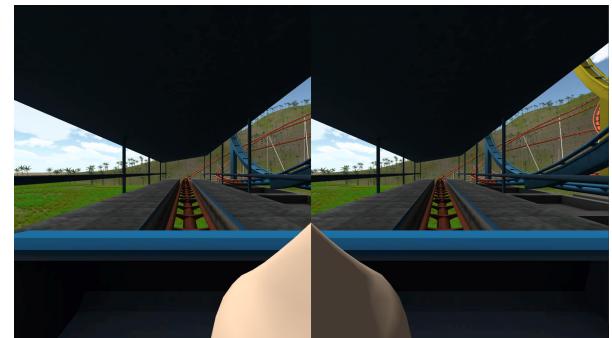
Minimize Cybersickness Contd.

- Steps for Minimizing Cybersickness:
 - Reduce latency by keeping a constant high framerate of 60 FPS
 - Avoid sudden acceleration and teleportation in VR environment
 - Limit teleportation
 - Helps with Vection (illusion of self-motion)
 - Smooth transition
 - Accurate position
 - Ground users to fixed objects within the experience
 - Virtual cockpits, chair, virtual nose, etc



Teleportation

"Design, Develop, and Deploy for VR." *Unity Learn*, learn.unity.com/course/oculus-vr



This screenshot is from one application where the user rides a roller coaster. Findings suggest the virtual nose reduces simulator sickness. (David Whittinghill/Purdue University image)

Minimize Cybersickness Contd.

- Steps for Minimizing Cybersickness Contd.:
 - Users should have control of the viewpoint
 - Users should initiate movements
 - Reduce/eliminate non-user initiated movements
 - Use Visual indicators (arrows) to indicate upcoming visual movements
 - Allow new users to adapt to the experience
 - Place objects at a comfortable viewing angle
 - 0.75 to 3.5 meters
 - Use Cybersickness Questionnaire to screen during development/testing phase
 - Explained in later slides

Measure Cybersickness

- Pensacola Motion Sickness Questionnaire (MSQ)
 - Developed in 2001
 - Asses 4 dimensions of motion sickness (gastrointestinal, central, peripheral, and soplete-related)
 - Based on 9-point Visual Analog Scale (VAS)
- Kennedy Simulator Sickness Questionnaire (SSQ)
 - Developed in 2009
 - Derived from MSQ
 - Developed specifically to quantify Simulator Sickness

Gianaros, P. J., Muth, E. R., Mordkoff, J. T., Levine, M. E., & Stern, R. M. (2001). A questionnaire for the assessment of the multiple dimensions of motion sickness.
Robert S. Kennedy, Norman E. Lane, Kevin S. Berbaum & Michael G. Lilienthal (1993) Simulator Sickness Questionnaire: An Enhanced Method for Quantifying Simulator Sickness

Measure Cybersickness Contd.

APPENDIX A

MOTION SICKNESS ASSESSMENT QUESTIONNAIRE (MSAQ).

Instructions. Using the scale below, please rate how accurately the following statements describe your experience

Not at all	Severely
1 — 2 — 3 — 4 — 5 — 6 — 7 — 8 — 9	
1. I felt sick to my stomach (G)	9. I felt disoriented (Q)
2. I felt faint-like (C)	10. I felt tired/fatigued (S)
3. I felt annoyed/irritated (S)	11. I felt nauseated (G)
4. I felt sweaty (P)	12. I felt hot/warm (P)
5. I felt queasy (G)	13. I felt dizzy (C)
6. I felt lightheaded (C)	14. I felt like I was spinning (C)
7. I felt drowsy (S)	15. I felt as if I may vomit (G)
8. I felt clammy/cold sweat (P)	16. I felt uneasy (S)

Note. G; Gastrointestinal; C; Central; P; Peripheral; SR; Sopite-related.

The overall motion sickness score is obtained by calculating the percentage of total points scored: (sum of points from all items/144) × 100. Subscale scores are obtained by calculating the percent of points scored within each factor: (sum of gastrointestinal items/36) × 100; (sum of central items/45) × 100; (sum of peripheral items/27) × 100; (sum of sopite-related items/36) × 100.

No _____

Date _____

SIMULATOR SICKNESS QUESTIONNAIRE

Kennedy, Lane, Berbaum, & Lilienthal (1993)***

Instructions : Circle how much each symptom below is affecting you right now.

1. General discomfort	<u>None</u>	<u>Slight</u>	<u>Moderate</u>	<u>Severe</u>
2. Fatigue	<u>None</u>	<u>Slight</u>	<u>Moderate</u>	<u>Severe</u>
3. Headache	<u>None</u>	<u>Slight</u>	<u>Moderate</u>	<u>Severe</u>
4. Eye strain	<u>None</u>	<u>Slight</u>	<u>Moderate</u>	<u>Severe</u>
5. Difficulty focusing	<u>None</u>	<u>Slight</u>	<u>Moderate</u>	<u>Severe</u>
6. Salivation increasing	<u>None</u>	<u>Slight</u>	<u>Moderate</u>	<u>Severe</u>
7. Sweating	<u>None</u>	<u>Slight</u>	<u>Moderate</u>	<u>Severe</u>
8. Nausea	<u>None</u>	<u>Slight</u>	<u>Moderate</u>	<u>Severe</u>
9. Difficulty concentrating	<u>None</u>	<u>Slight</u>	<u>Moderate</u>	<u>Severe</u>
10. « Fullness of the Head »	<u>None</u>	<u>Slight</u>	<u>Moderate</u>	<u>Severe</u>
11. Blurred vision	<u>None</u>	<u>Slight</u>	<u>Moderate</u>	<u>Severe</u>
12. Dizziness with eyes open	<u>None</u>	<u>Slight</u>	<u>Moderate</u>	<u>Severe</u>
13. Dizziness with eyes closed	<u>None</u>	<u>Slight</u>	<u>Moderate</u>	<u>Severe</u>
14. *Vertigo	<u>None</u>	<u>Slight</u>	<u>Moderate</u>	<u>Severe</u>
15. **Stomach awareness	<u>None</u>	<u>Slight</u>	<u>Moderate</u>	<u>Severe</u>
16. Burping	<u>None</u>	<u>Slight</u>	<u>Moderate</u>	<u>Severe</u>

* Vertigo is experienced as loss of orientation with respect to vertical upright.

** Stomach awareness is usually used to indicate a feeling of discomfort which is just short of nausea.

Last version : March 2013

***Original version : Kennedy, R.S., Lane, N.E., Berbaum, K.S., & Lilienthal, M.G. (1993). Simulator Sickness Questionnaire: An enhanced method for quantifying simulator sickness. *International Journal of Aviation Psychology*, 3(3), 203-220.