



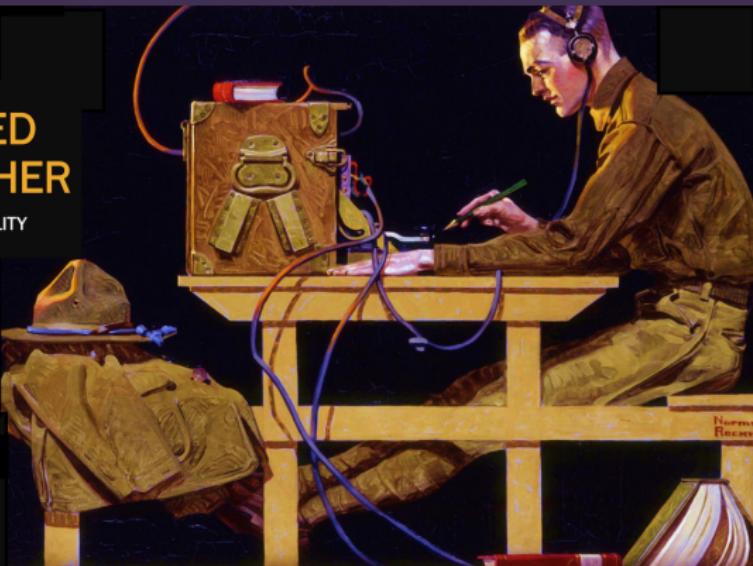
PEP270: Augmented & Virtual Reality

7:

THE AUGMENTED TELEGRAPHER

MULTIPLAYER MIXED REALITY
IN A MUSEUM CONTEXT

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Virtual and Augmented Reality Overview:

Learning Outcomes:

- ▶ **Explain** the difference between augmented & virtual reality.
- ▶ **Discuss** the differences between immersion and presence
- ▶ **Outline** the various technologies and human factors that combine to create a sense of presence in the user

3 Weeks distilled into one hour

A Word of Warning

AR/VR are both emerging technologies and thus, they borrow language from other similar disciplines such as **photography**, game development, film studies and 3D design. This appropriation of lexicons can be confusing and there will be some overlap in relation to key terms and definitions.

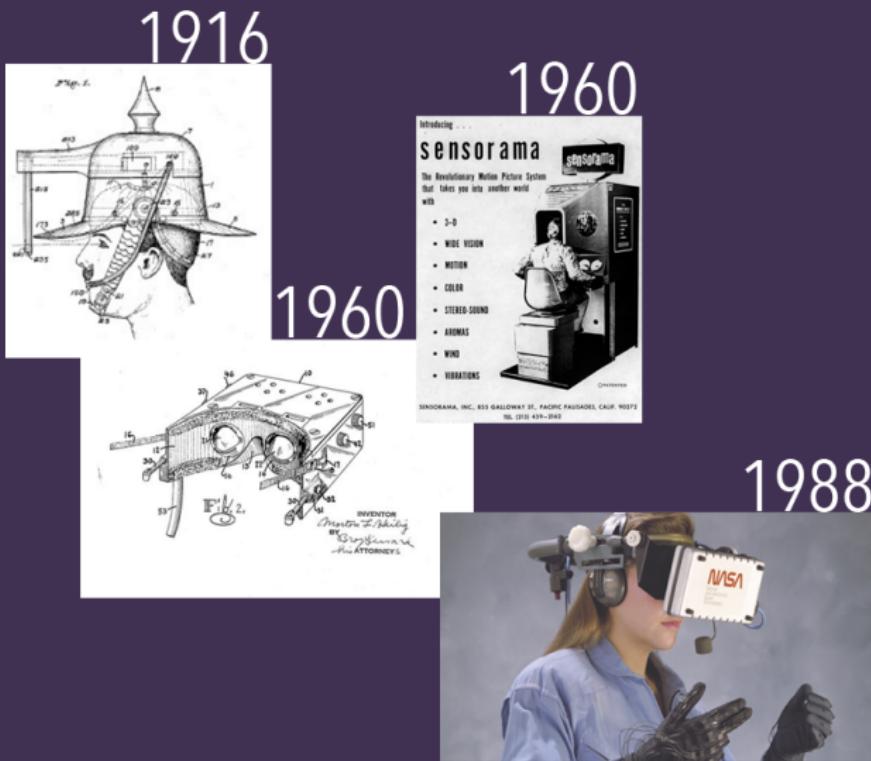


Figure: Left to Right - Pratt's head-mounted targeting interface, Heilig's Stereoscope TV Apparatus & Sensorama, NASA's VIEW System

Forms of Reality

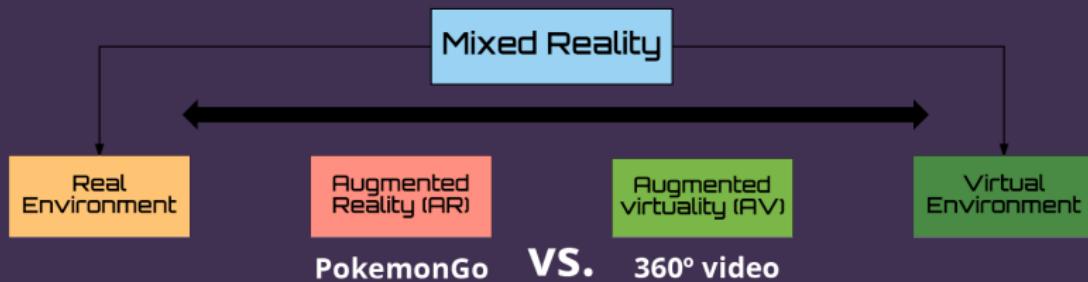
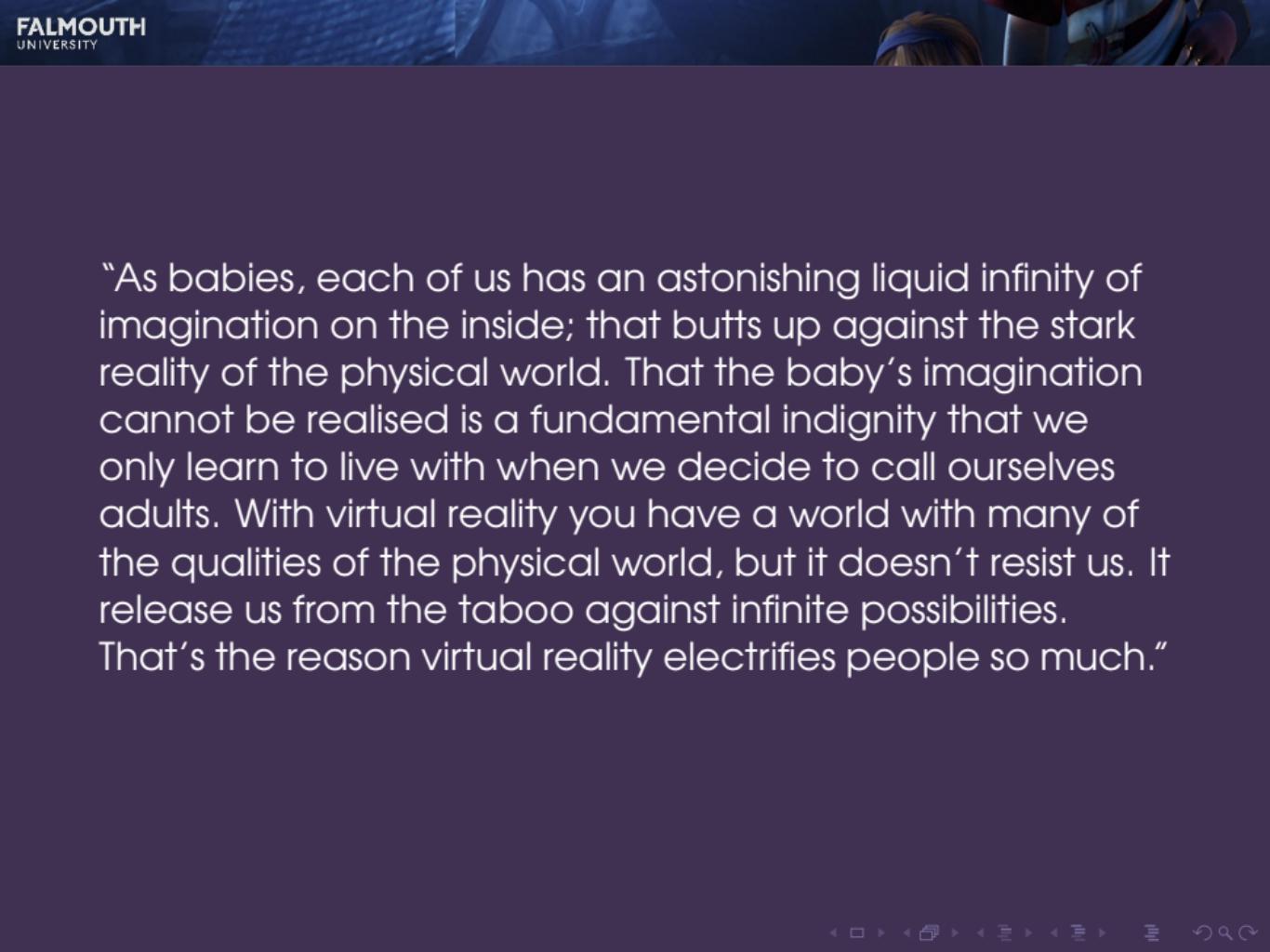


Figure: The Virtuality Continuum - Milgram & Kishino



The term 'virtual reality' was coined by Jaron Lanier in 1987 during a period of intense research activity into this form of technology.



"As babies, each of us has an astonishing liquid infinity of imagination on the inside; that butts up against the stark reality of the physical world. That the baby's imagination cannot be realised is a fundamental indignity that we only learn to live with when we decide to call ourselves adults. With virtual reality you have a world with many of the qualities of the physical world, but it doesn't resist us. It release us from the taboo against infinite possibilities. That's the reason virtual reality electrifies people so much."

Reality Systems - Hardware

Display Types:

- ▶ Head-Mounted Displays
- ▶ World-Fixed Displays
- ▶ Hand-held Displays
 - (tablets = floating,
mobile = personal)

Audio: Spatialised Audio is preferred

- ▶ Headphones - more immersive.
- ▶ surround sound speakers.

Head-Mounted Displays (HMD)



And then there is Magic Leap



World-Fixed Display

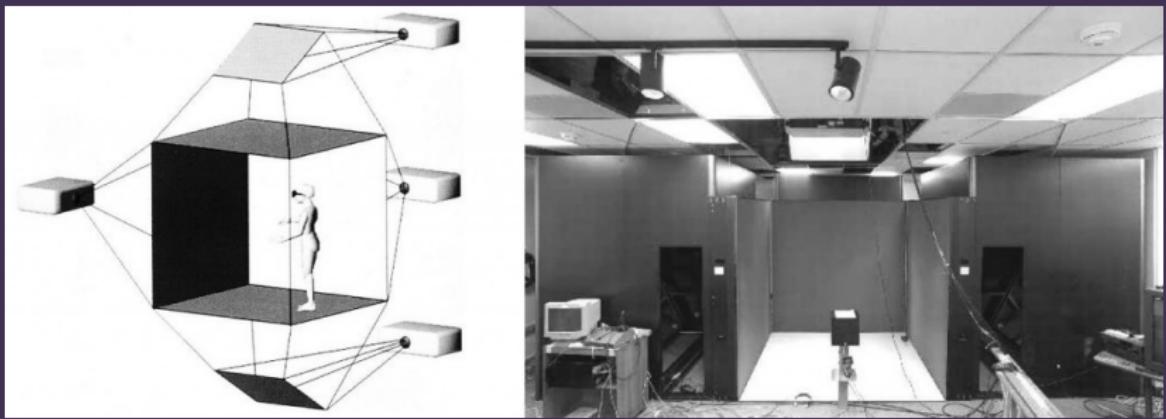


Figure: Cave VR environment: A lifelike visual display is created by projectors positioned outside the CAVE and controlled by physical movements from a user inside the CAVE.

Hand-held displays



Figure: Pokemon Go

Tracking

- ▶ Accelerator & Gyro embedded in displays
- ▶ Leap motion - Hand Tracking
- ▶ Eye Tribe (Foveated rendering)
- ▶ Fiducials Markers
- ▶ Kinect2 - Skeleton Tracking
- ▶ Valve's Lighthouse Tracking Sensors
- ▶ Vive Trackers (Link)

Tracking

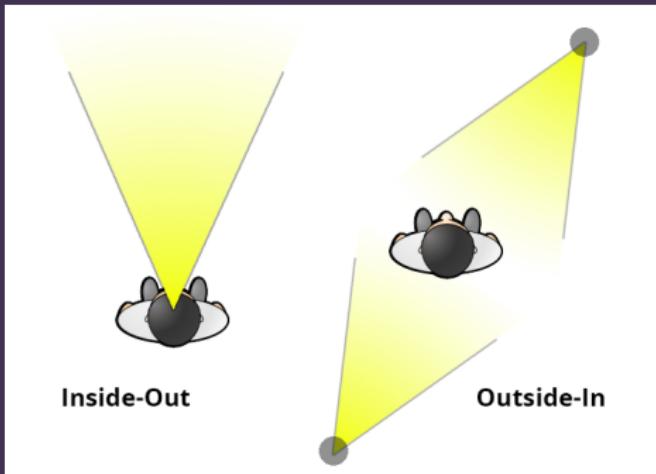


Figure: Pokemon Go

Haptics

Haptics are the artificial forces between virtual objects and the user.

Passive - real-world physical objects that match the shapes of a virtual objects. (Doors, ledges, pillars...)

Active - Haptics can be dynamically controlled by the computer to provide a feeling of a wide range of simulated virtual objects.



Figure: University of North Carolina - Pit Experiment

Tactile Haptics

- ▶ Vibrotactile - vibration passed directly or indirectly to the skin
- ▶ Electrotactile - electrodes passing current through the skin
- ▶ Proprioceptive force - provides a sense of limb movement and muscular resistance

Self-Grounded vs. World-Grounded Haptics

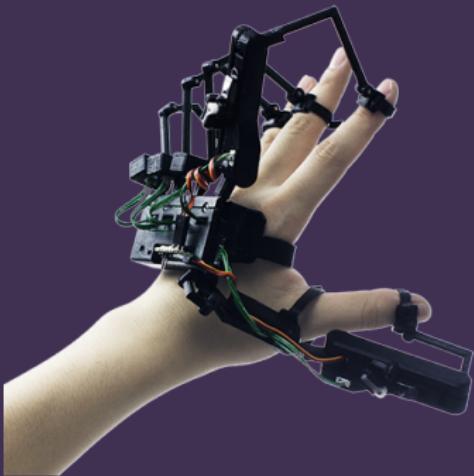


Figure: DexmoF2 & Sensable's Phantom Haptic System

Motion Platforms

A motion platform is a hardware device that moves the entire body resulting in a sense of physical motion and gravity.

These systems can convey a sense of orientation, vibration, acceleration and jerking.

(Examples)



Omni



Human-Centred Design:

Some tips when designing for AR & VR

Continuous Discovery

Continuous discovery is the on-going process of engaging users during the design and development process.

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- ▶ Change is inevitable.
- ▶ Failures are an inevitable outcome of creativity and innovation.

Iteration

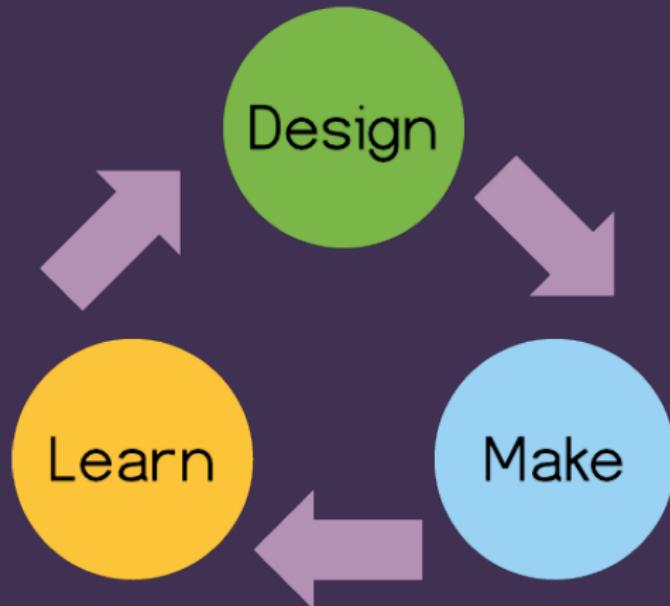


Figure: The Iteration Cycle

ASK QUESTIONS

- ▶ Feedback is crucial - you require a lot of trust from the user!
- ▶ Ask lots of questions.
- ▶ Do not trust assumptions.
- ▶ Common misconception.

Immersion

Immersion is the objective degree to which a VR system and application projects stimuli onto the sensory receptors. We discuss immersion in terms of:

- ▶ Extensiveness - Range of sensory modalities targeted
- ▶ Matching - Stimuli vs reality
- ▶ Surrounding - Extent of environment (panoramic) and tracking
- ▶ Vividness - The quality of simulation
- ▶ Intractability - The quality of the input and outputs
- ▶ Plot - How compelling the narrative is



Figure: The Lawnmower Man - 1992

Not the last Lawnmower Man ref you will see today ;)

Immersion vs. Presence

‘Presence is the psychological state of subjective perception in which even though part or all of an individual’s current experience is generated by and/or filtered through human-made technology, part or all of the individual’s perception fails to accurately acknowledge the role of the technology in the experience.’

International Society for Presence Research, 2000

(ISPR Website)

Perceptual Modalities

"A perceptual modality can be defined as the means through which information is extracted from the environment" (James and Galbraith, 1985)

Immersion is created by surrounding the user of the VR system in images, sound or other stimuli that provide an engrossing total environment.

In order to achieve an illusion of immersion a reality system must consider the perceptual modalities: **Sight, hearing, touch, proprioception, balance/motion, smell and taste.**

Field of View and Field of Regard

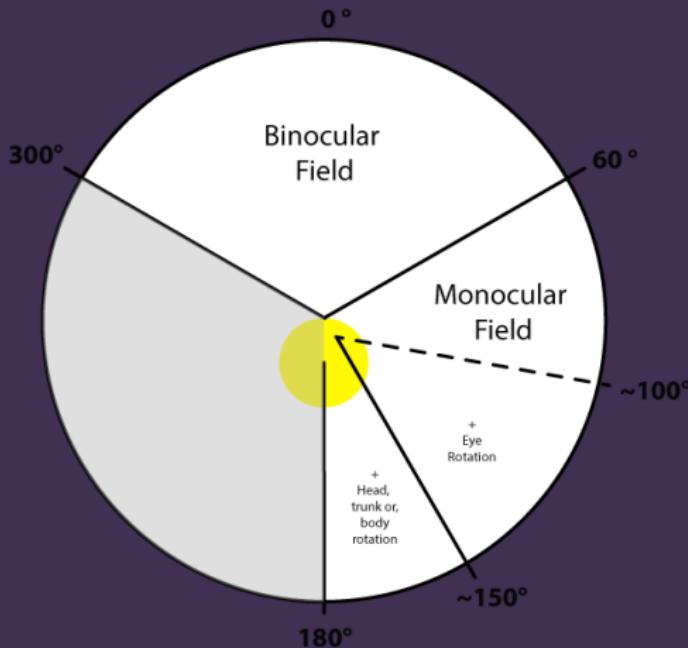


Figure: Horizontal field of view of the right eye with straight ahead fixation (looking towards the top of the diagram)

Chromatic Aberration

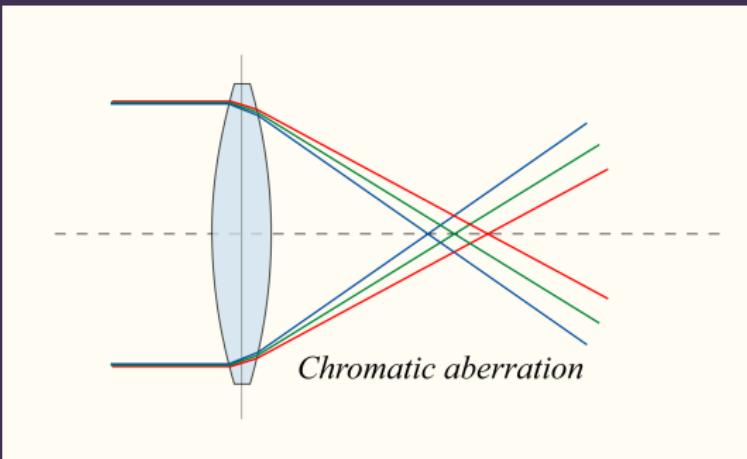


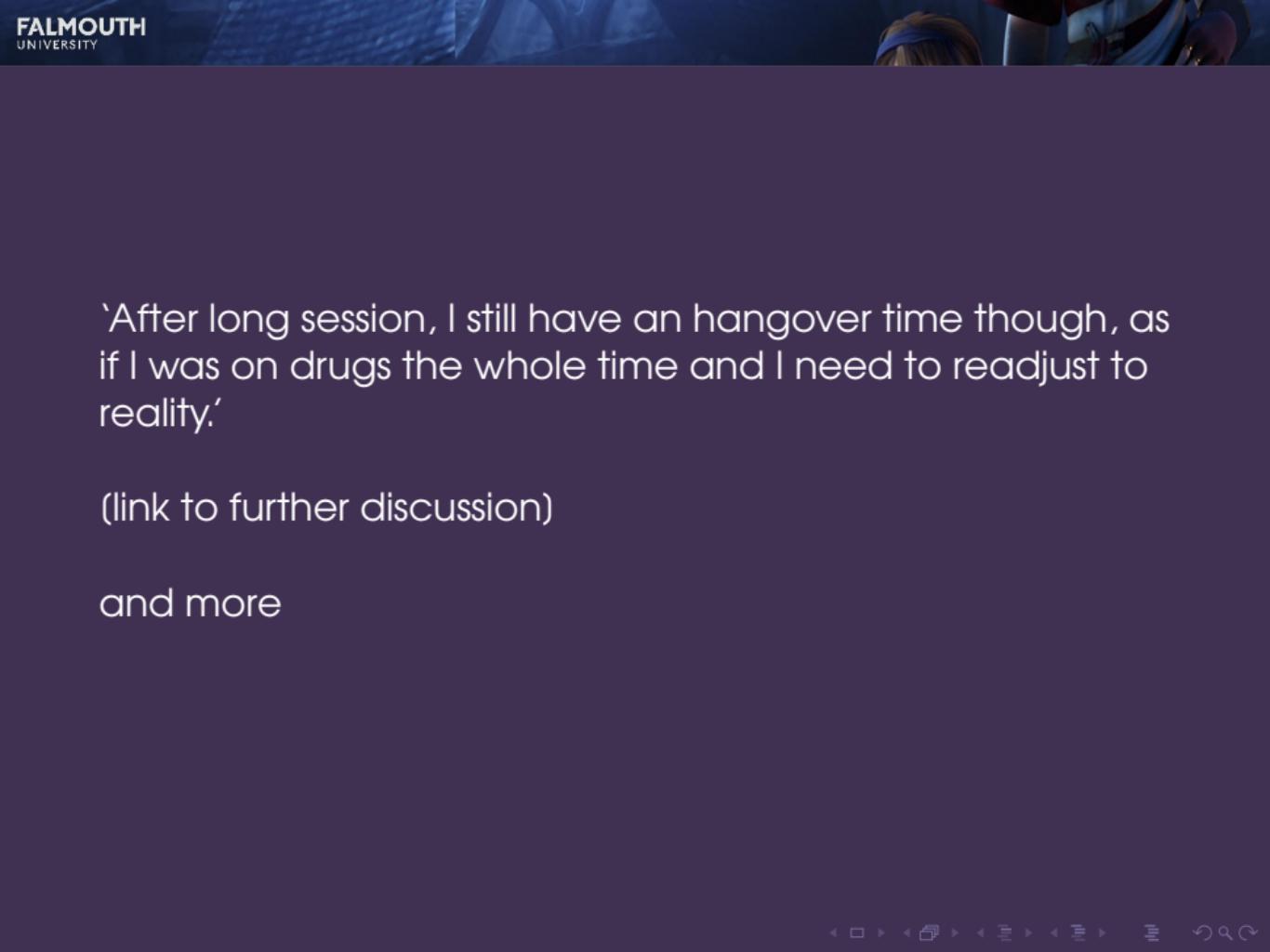
Figure: When different wavelengths of light refract at different angles. Movement of the eye can amplify the aberration.
aberration:a departure from what is normal

Vergence-Accommodation Conflict

Vergence - How your eyes track an object coming towards you.

Accommodation - When your pupils adjust to the object's light field.

The two actions are hardwired to work in sync as they are both trying aid the same process of tracking an object. They can be decoupled but it is not a comfortable experience for the user.



'After long session, I still have an hangover time though, as if I was on drugs the whole time and I need to readjust to reality.'

(link to further discussion)

and more

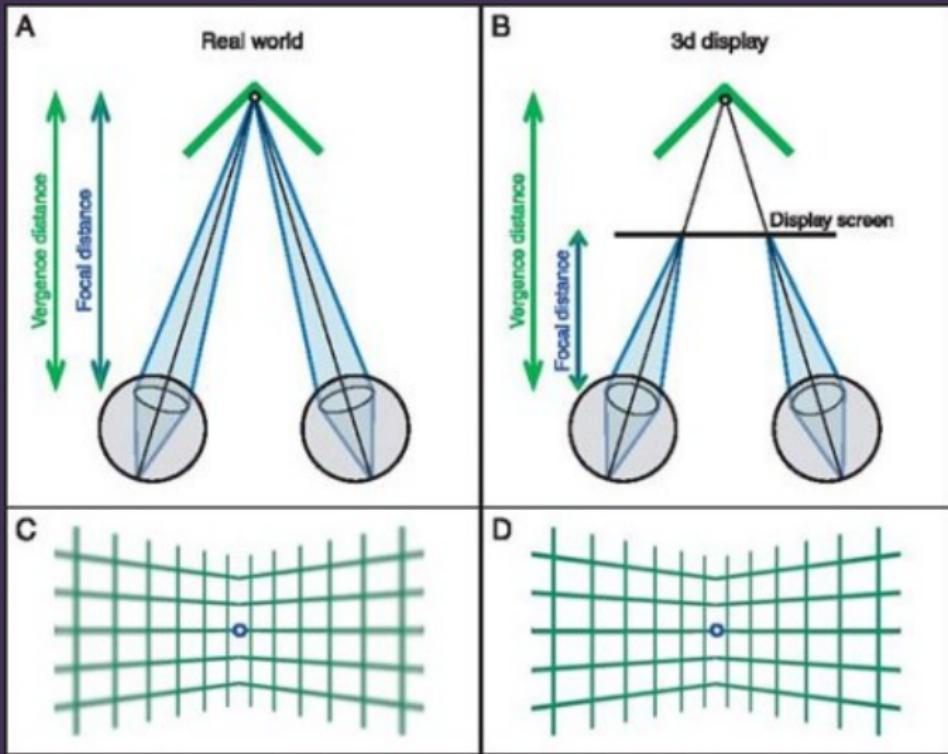


Figure: Vergence-Accommodation Conflict

Motion to Photon Latency

- ▶ **Motion** - refers to the users movements in the physical space.
- ▶ **Photons** - The photons emitted from the HMD that are absorbed by photoreceptors (cones & rods) on the retina.
- ▶ **Latency** - delay between the two.

Put simply, motion to photon latency is the time it takes for the users movements in physical space to be visualised on the head-mounted display(HMD).

Side Effects

The <20ms motion-to-photon latency gold standard.

When the motion to photon latency is greater than 20ms or anytime there is inconsistent stimuli between the players physical body motions and the visuals displayed in the head-mounted display (HMD) then there is a good chance that motion sickness/simulator sickness will occur.

According to the Oculus Rift docs, other factors that can contribute to simulator sickness are:

- ▶ Acceleration - minimize the size and frequency of accelerations
- ▶ Degree of control - don't take control away from the user
- ▶ Duration of simulator use - allow and encourage users to take breaks
- ▶ Altitude - avoid filling the field of view with the ground
- ▶ Binocular disparity - some find viewing stereoscopic images uncomfortable
- ▶ Field-of-View - reducing the amount of visual field covered by the virtual environment may also reduce comfort
- ▶ ... (the list goes on)

- ▶ Latency - minimize it; lags/dropped frames are uncomfortable in VR
- ▶ Distortion correction - use Oculus VR's distortion shaders
- ▶ Flicker - do not display flashing images or fine repeating textures
- ▶ Experience - experience with VR makes you resistant to simulator sickness (which makes developers inappropriate test subjects)

Oculus Rift Health & Safety Guide

Health and Safety

* These health & safety warnings are periodically updated for accuracy and completeness. Check www.oculus.com/warnings for the latest version.

⚠ WARNING

HEALTH & SAFETY WARNINGS: TO REDUCE THE RISK OF PERSONAL INJURY, DISCOMFORT OR PROPERTY DAMAGE, PLEASE ENSURE THAT ALL USERS OF THE HEADSET READ THE WARNINGS BELOW CAREFULLY BEFORE USING THE HEADSET.

⚠ WARNING

Before Using the Headset:

- Read and follow all setup and operating instructions provided with the headset.
- Review the hardware and software recommendations for use of the headset. Risk of discomfort may increase if recommended hardware and software are not used.
- Your headset and software are not designed for use with any unauthorized device, accessory and/or software. Use of an unauthorized device, accessory and/or software may result in injury to you or others, may cause performance issues or damage to your system and related services.
- To reduce the risk of discomfort, adjust the inter-pupillary distance (IPD) for each user before use of the headset.
- A comfortable virtual reality experience requires an unimpaired sense of motion and balance. Do not use the headset when you are: Tired; need sleep; under the influence of alcohol or drugs; have allergies; have digestive problems; under emotional stress or anxiety; or when suffering from cold, flu, headaches, migraines, or earaches, as this can increase your susceptibility to adverse symptoms.
- We recommend seeing a doctor before using the headset if you are pregnant, elderly, have pre-existing binocular vision abnormalities or psychiatric disorders, or suffer from a heart condition or other serious medical condition.

⚠ WARNING

Seizures:

Some people (about 1 in 4000) may have severe dizziness, seizures, eye or muscle twitching or blackouts triggered by light flashes or patterns, and this may occur while they are watching TV, playing video games or experiencing virtual reality, even if they have never had a seizure or blackout before or have no history of seizures or epilepsy. Such seizures are more common in children and young people under the age of 20. Anyone who experiences any of these symptoms should discontinue use of the headset and see a doctor. Anyone who previously

has had a seizure, loss of awareness, or other symptom linked to an epileptic condition should see a doctor before using the headset.

⚠ WARNING

Children:

This product should not be used by children under the age of 13, as the headset is not sized for children and improper sizing can lead to discomfort or health effects, and younger children are in a critical period in visual development. Adults should make sure children (age 13 and older) use the headset in accordance with these health and safety warnings including making sure the headset is used as described in the Before Using the Headset section and the Safe Environment section. Adults should monitor children (age 13 and older) who are using or have used the headset for any of the symptoms described in these health and safety warnings (including those described under the Discomfort and Repetitive Stress Injury sections), and should limit the time children spend using the headset and ensure they take breaks during use. Prolonged use should be avoided, as this could negatively impact hand-eye coordination, balance, and multi-tasking ability. Adults should monitor children closely during and after use of the headset for any decrease in these abilities.

⚠ WARNING

General Precautions:

To reduce the risk of injury or discomfort you should always follow these instructions and observe these precautions while using the headset:

- **Use Only In A Safe Environment:** The headset produces an immersive virtual reality experience that distracts you from and completely blocks your view of your actual surroundings.
 - Always be aware of your surroundings before beginning use and while using the headset. Use caution to avoid injury.
 - Use of the headset may cause loss of balance.
- **Remain seated unless your game or content experience requires standing.**

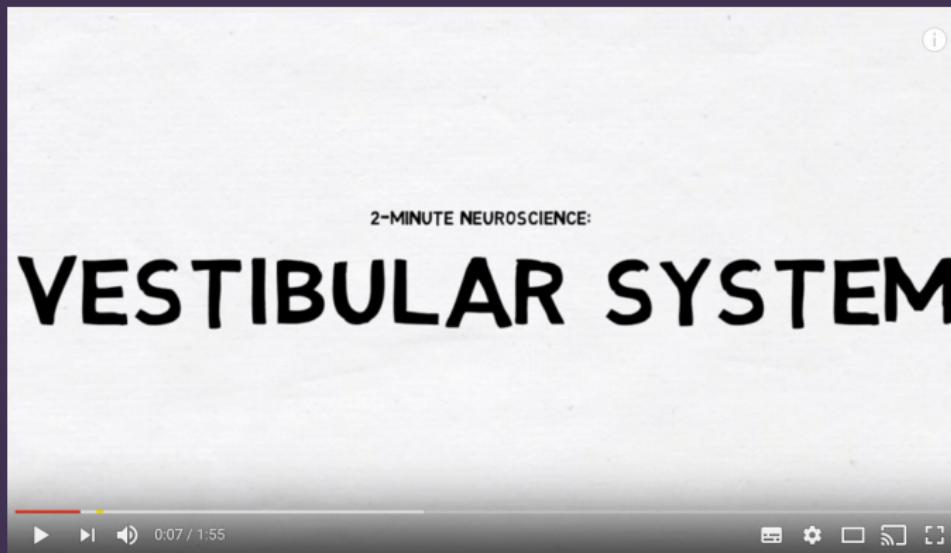


Balance

There are three systems at work to aid in balance:

- ▶ Vestibular System (motion, equilibrium, spatial orientation)
- ▶ Proprioception (position, motion, and equilibrium)
- ▶ Vision (sight)

Vestibular System





Visually induced motion sickness (VIMS) is a specific type of motion sickness caused by a conflict between vision and both the proprioception and vestibular systems.

According to Forbes, when a player is cycling a bike in VR, they have a tendency to lean to accommodate for cornering, and as a consequence they fall off.

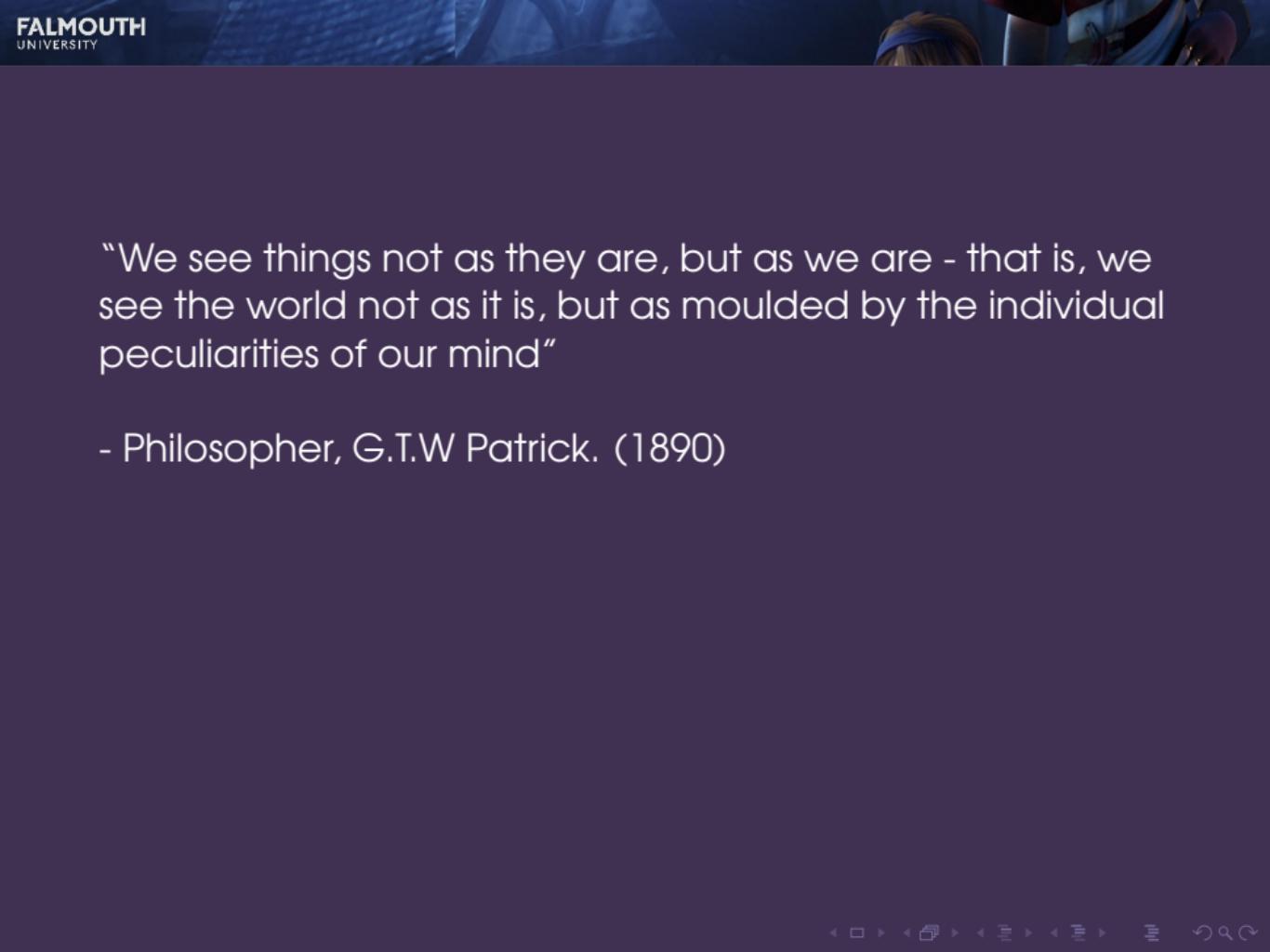
When traditional big screens cause VIMS the viewer can just look away but in VR this is not possible.

Presence (again)

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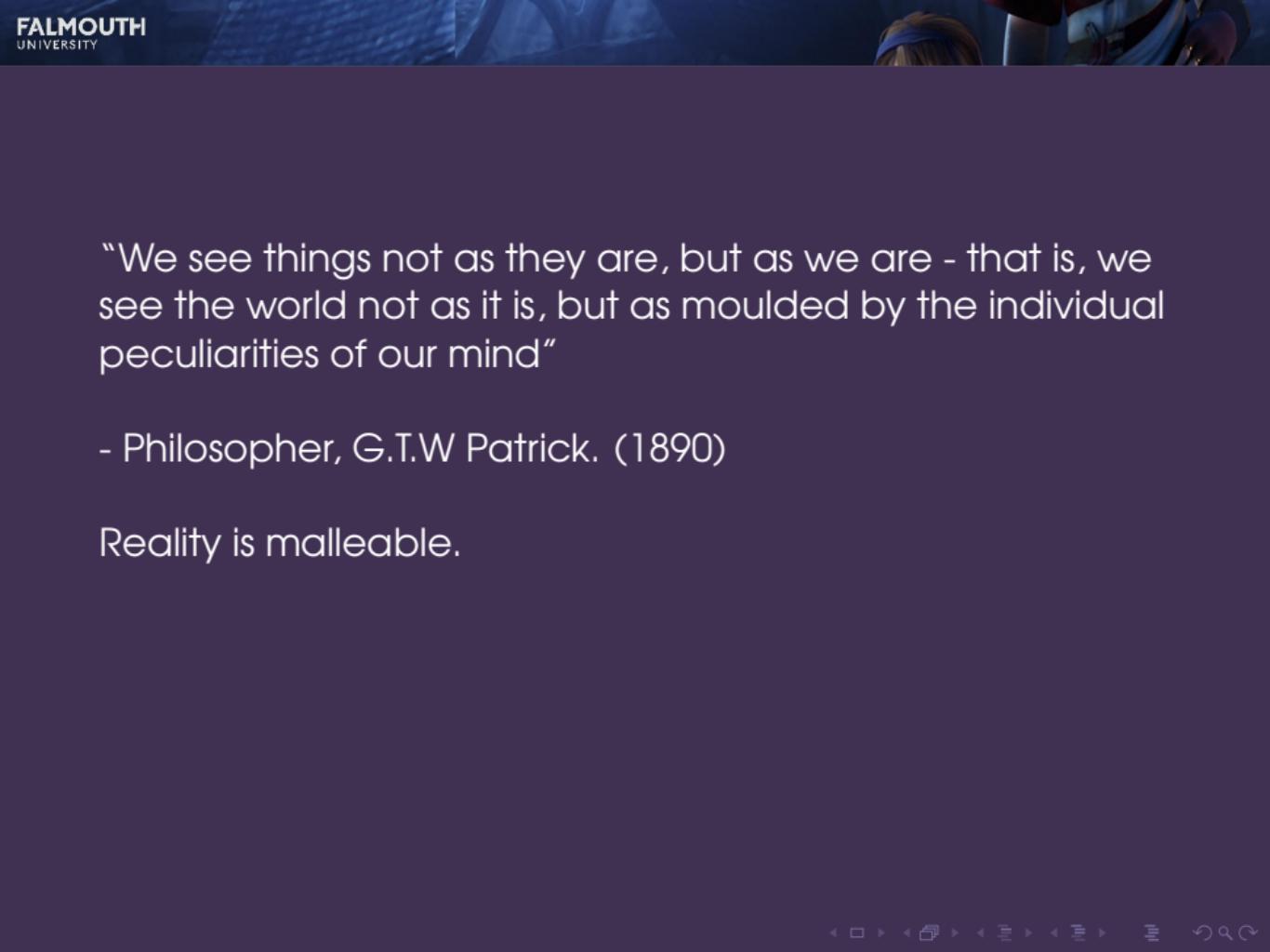
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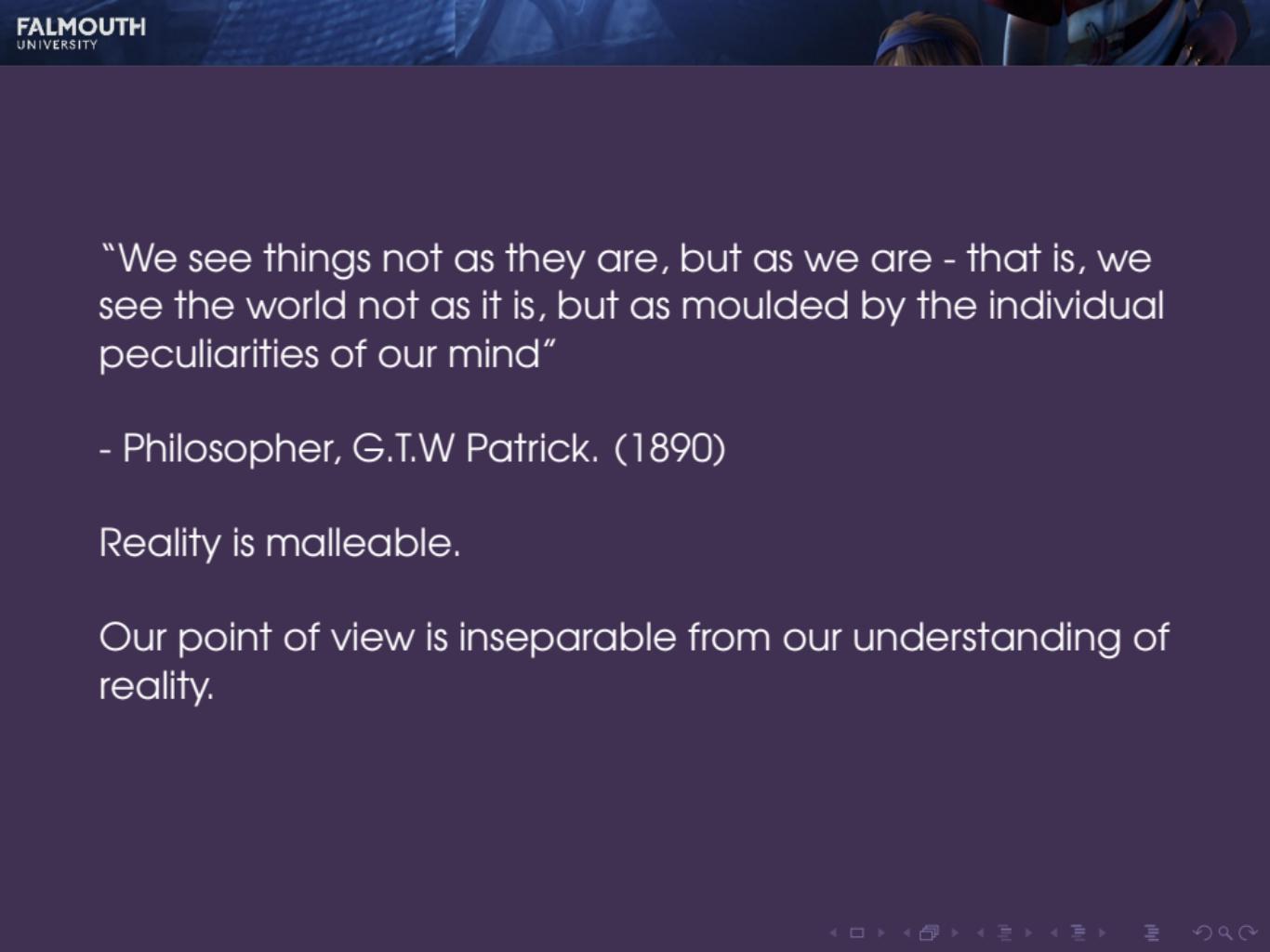
- Philosopher, G.T.W Patrick. (1890)



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Reality is malleable.



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Reality is malleable.

Our point of view is inseparable from our understanding of reality.



Figure: The Lawn Mower Man - 1992

Duck Test

“a colloquial name for a method of testing if an experiencer has reached a state of presence, by monitoring their behaviour when threatened by a virtual object”

- VRGlossary.org

This could have an adverse effect if the experiencer realises that there is no actual risk - Presence is then broken.



Figure: Michael Abrash, the chief scientist for Facebook's Oculus

Types of Illusion

- ▶ Boundary Completion
- ▶ Blind Spot (link to eye)
- ▶ Depth Illusions - Trompe-l'œil
- ▶ Afterimage
- ▶ Motion Illusions - Watch these in VR as they cause motion sickness.

Illusions

V/AR are illusion based experiences

There are four main components to this illusion:

- ▶ the stable spacial place,
- ▶ self-embodiment,
- ▶ physical interaction &
- ▶ social communication.

Reality is Subjective

By this point we are starting to get a sense that what we perceive is not necessarily real.

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So what is getting in the way of reality?

Iterative Processing

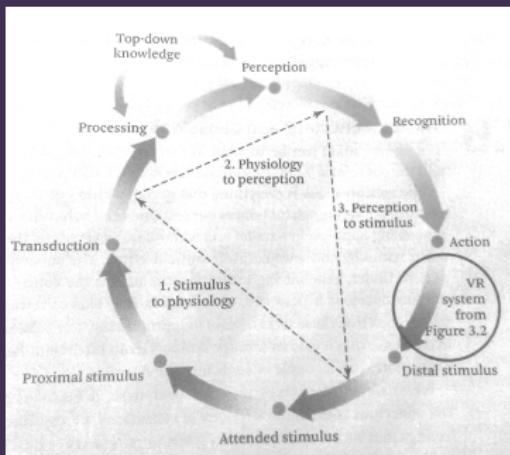


Figure: We continually receive, process and perceive stimuli in an iterative loop

The Uncanny Valley

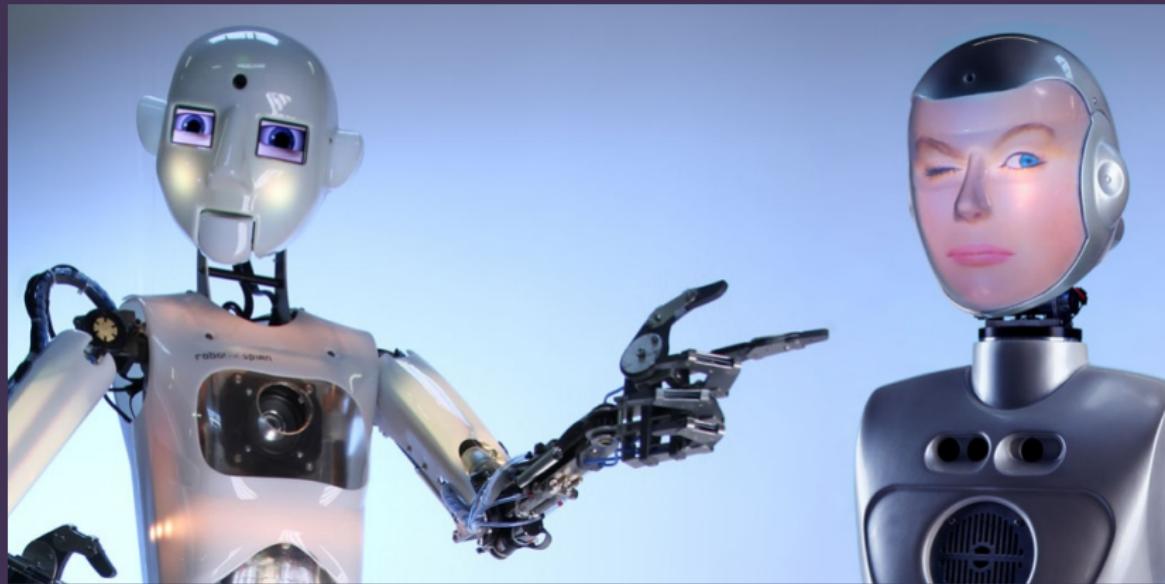


Figure: Engineered Arts - Penryn

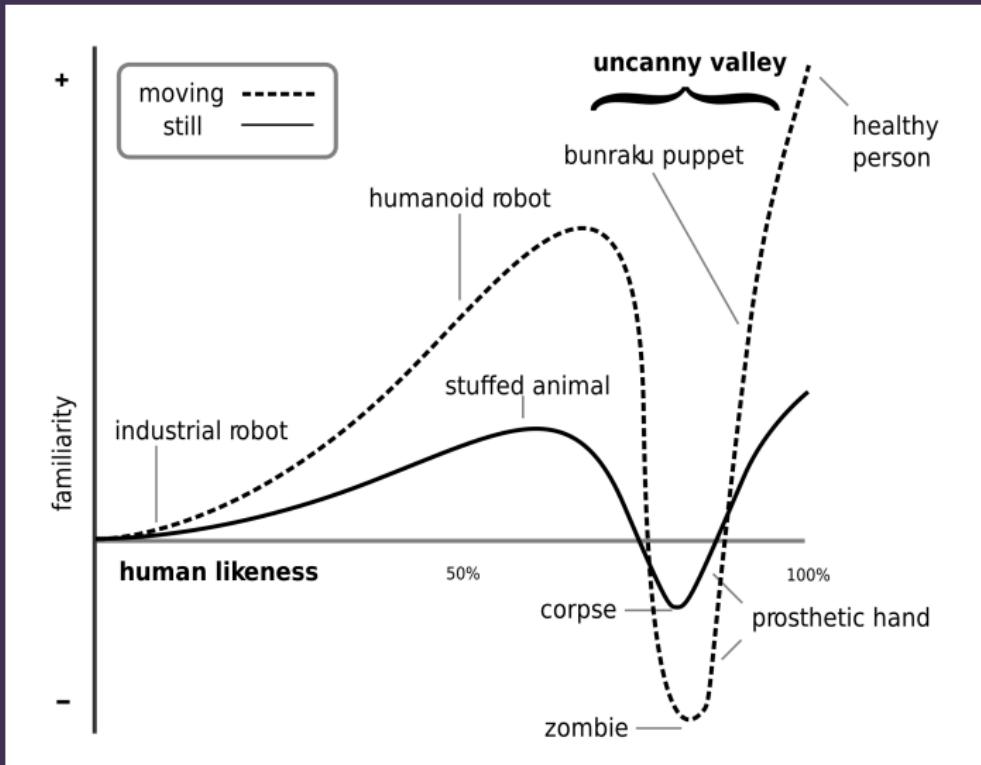
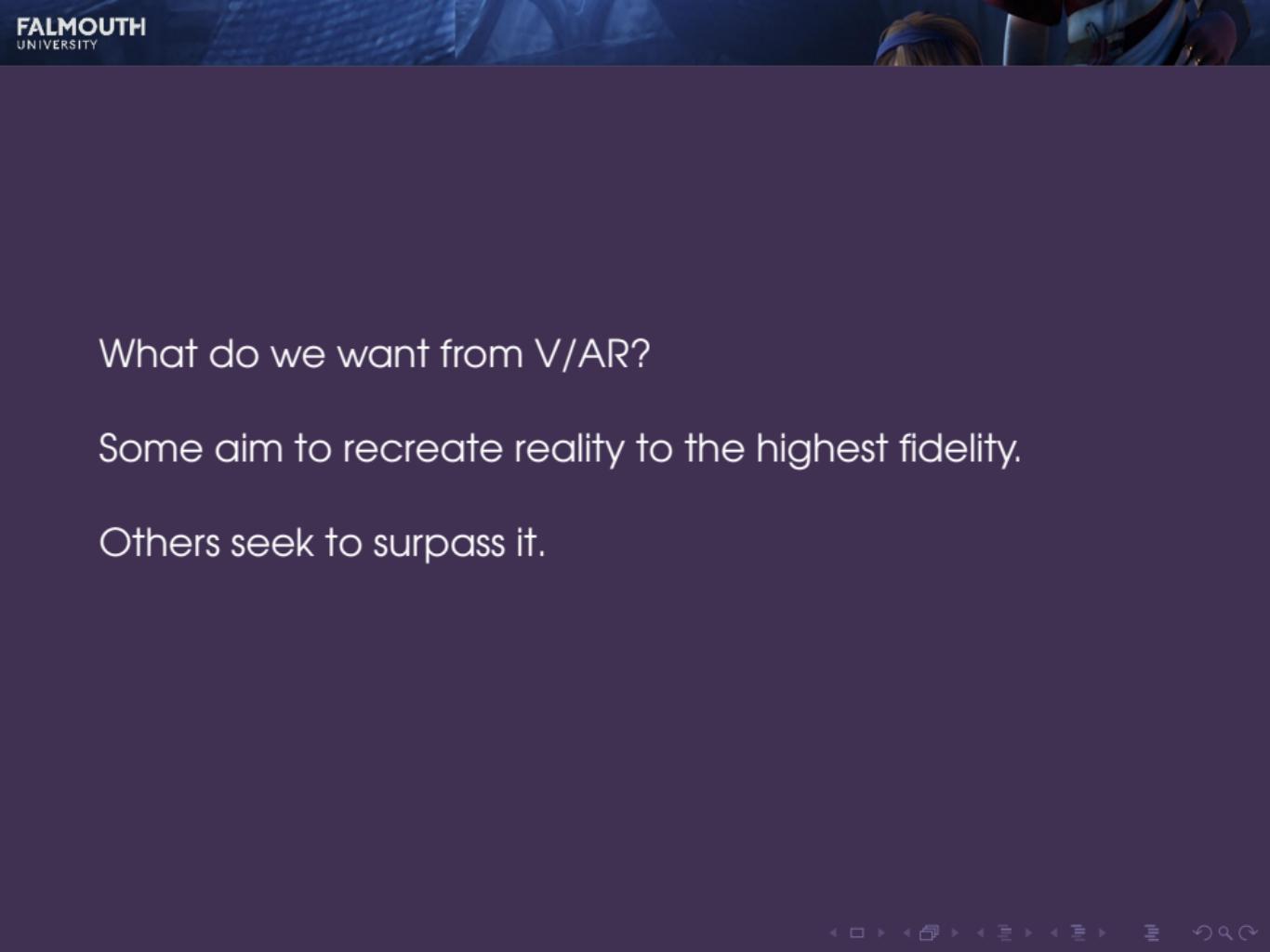


Figure: Masahiro Mori -

Fidelity Continua

The notion of the uncanny valley applies to aspects of VR as well. These components have been defined as the Fidelity Continua.

- ▶ **Representation** fidelity - Hyper-realistic to abstract and non-objective worlds.
- ▶ **Interaction** Fidelity - Degree to which a interaction in VR corresponds with the same interaction in the real world.
- ▶ **Experiential** Fidelity - The degree to which the user experience matches the intentions of the VR creator. Procedural worlds have a very low experiential fidelity.

A dark blue background image showing a close-up of a person's face wearing a virtual reality headset. The person has blonde hair and is looking slightly to the side. The image is partially visible at the top of the slide.

What do we want from V/AR?

Some aim to recreate reality to the highest fidelity.

Others seek to surpass it.

Misdirection

“That which directs a spectator away from the method and towards the effect”

Curtis Hickman - Magician & founder of THE VOID.

TRUTH/REALITY >GUIDED PERCEPTION >LIE/FANTASY

LINK

Sensation vs. Perception



Sensation - Lower level recognition of stimuli.

Perception - Higher level processing that combines information from the senses, filters it, organises it then interprets it to create **subjective**, conscious experience.