Augmented Reality & Virtual Reality

SWEN422

Human Computer Interaction

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Class Announcements

- Assignment 2 extension 2359 Friday 24 May
- Assignment 3
- NZ Testing Conference @ VUW – 27 June
  - Want volunteers
  - volunteer@nztestingconf.nz
  - https://nztestingconf.nz/
- Kiwi Python Conference, Wellington, 23-25 August
  - https://kiwipycon.nz/

SWEN 422 – Lecture Schedule

- ~~Week 6 – Information Visualization~~
- ~~Week 7 – Information Visualization~~
- ~~Week 8 – Information Visualization~~
- ~~Week 9 – Gestural Interfaces~~
- Week 10 - AR/VR (Introduction and Research Papers)
- Week 11 - AR/VR (Research)
- Week 12 - no lectures (work on project)

https://ecs.wgtn.ac.nz/Courses/SWEN422_2024T1/LectureSchedule

Introduction

- VR has been a hot topic for decades.

- 1960s predictions of virtual worlds in early 21st century.

- Technological progress?

- Scale/degree of virtual reality?

- Human reality versus computer reality.

Intro Videos:
https://www.youtube.com/watch?v=D61flqml22o
https://www.youtube.com/watch?v=43mA_ypfwKg
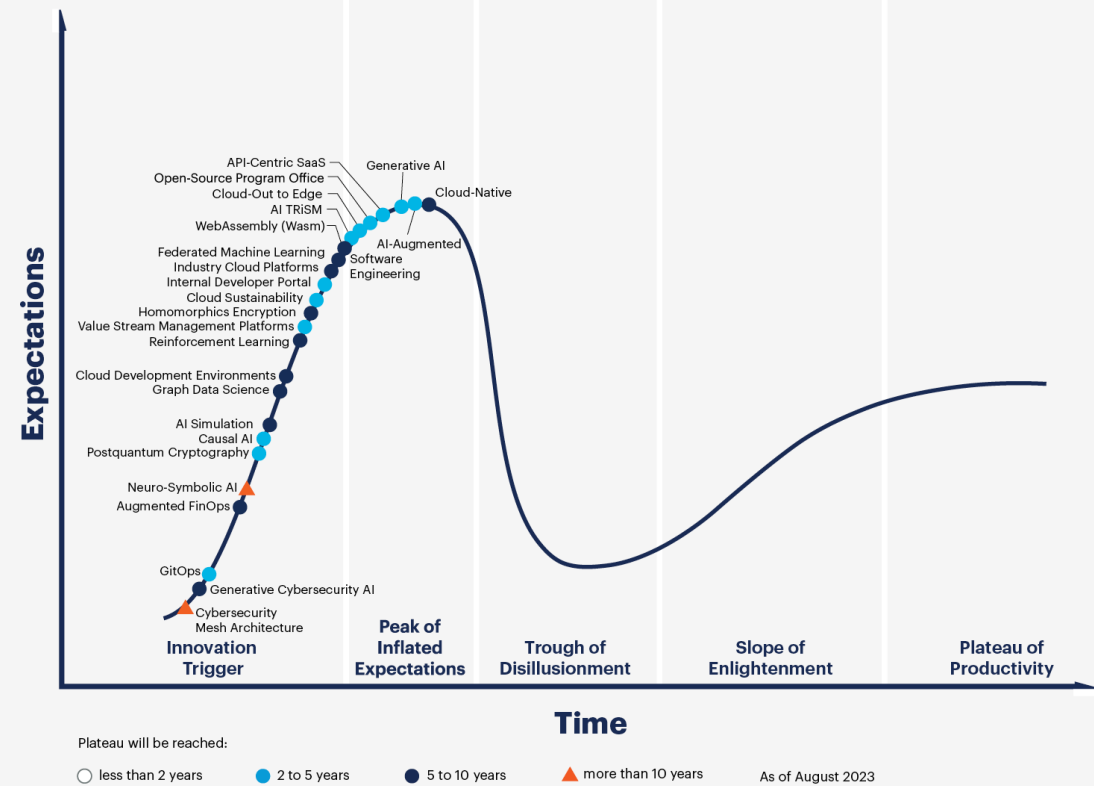https://www.youtube.com/watch?v=hDWfsIbBtwE

#VirtualReality has been removed from the Gartner Hype Cycle. This is interesting because it means that it's now a technology. Not necessarily a mature technology, but a tech that's no longer inflated or deflated by the hype cycle.

Hype Cycle for Emerging Technologies, 2020

Expectations

Secure Access Service Edge (SASE)
Social Distancing Technologies
Explainable AI
Embedded AI
Data Fabric
Composable Enterprise
AI Augmented Development
Carbon-Based Transistors
Responsible AI
Multiexperience
Digital Twin of the Person
Citizen Twin
Packaged Business Capabilities
Generative AI
Composite AI
Bring Your Own Identity
Adaptive ML
Social Data
Private 5G
Generative Adversarial Networks
Differential Privacy
Biodegradable Sensors
2-Way BMI (Brain Machine Interface)
Health Passport
Ontologies and Graphs
Self-Supervised Learning
Low-Cost Single-Board Computers at the Edge
DNA Computing and Storage
AI-Assisted Design
Authenticated Provenance

Innovation Trigger | Peak of Inflated Expectations | Trough of Disillusionment | Slope of Enlightenment | Plateau of Productivity

Time

Plateau will be reached:

Hype Cycle for Emerging Technologies, 2023

Expectations

API-Centric SaaS
Open-Source Program Office
Cloud-Out to Edge
AI TRiSM
WebAssembly (Wasm)
Generative AI
Cloud-Native
AI-Augmented Software Engineering
Federated Machine Learning
Industry Cloud Platforms
Internal Developer Portal
Cloud Sustainability
Homomorphics Encryption
Value Stream Management Platforms
Reinforcement Learning
Cloud Development Environments
Graph Data Science
AI Simulation
Causal AI
Postquantum Cryptography
Neuro-Symbolic AI
Augmented FinOps
GitOps
Generative Cybersecurity AI
Cybersecurity Mesh Architecture

Innovation Trigger | Peak of Inflated Expectations | Trough of Disillusionment | Slope of Enlightenment | Plateau of Productivity

Time

Plateau will be reached:

○ less than 2 years   ● 2 to 5 years   ● 5 to 10 years   ▲ more than 10 years   As of August 2023

gartner.com

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Gartner®

Sensorama

- Morton Heilig
- 1962
- Mechanical
- Stereoscopic 3D
- Stereo sound.
- Body tilting.
- Wind + aromas.

https://www.youtube.com/watch?v=E6Ja4R-qhQo

Sutherland's Vision
"The Ultimate Display" (1965)

- Display as a window into a virtual world.

- Improve image generation until the picture looks real.

- Computer maintains world model in real time.

- User directly manipulates virtual objects.

- Manipulated objects move realistically.

- Immersion in virtual worlds via head-mounted display.

- Virtual world also sounds real, feels real.

Early Days – Sword of Damocles

- Ivan Sutherland, 1965.

- Wireframe room, perspective dependent on user's gaze.

- First virtual reality head-mounted display.
  - Head unit attached to mechanical arm extended from ceiling.

https://www.youtube.com/watch?v=eVUgfUvP4uk

The Incredible Disappearing Computer

THE INVISIBLE COMPUTER

DONALD A. NORMAN

WHY GOOD PRODUCTS CAN FAIL,
THE PERSONAL COMPUTER IS SO COMPLEX,
AND INFORMATION APPLIANCES ARE THE SOLUTION

1960-70's

1970-80's

1980-90's

1990-2000's

Room

Desk

Lap
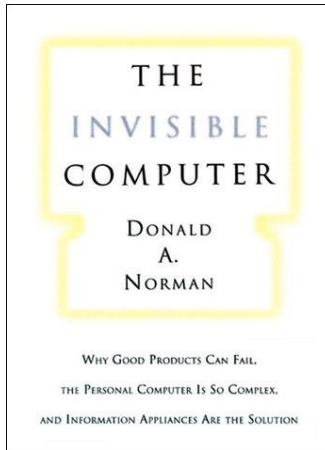
Hand

Making Interfaces Invisible
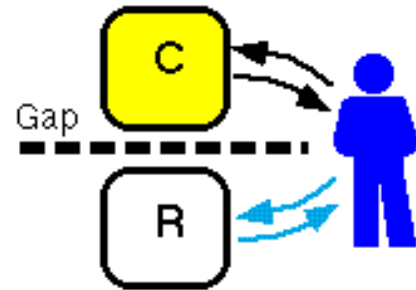
(a) GUI
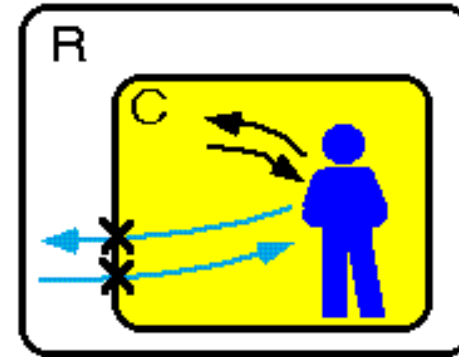
(b) Virtual Reality
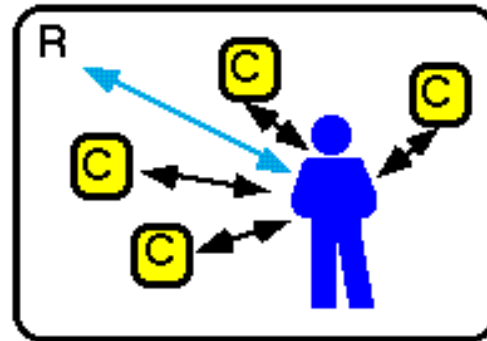
(c) Ubiquitous Computers
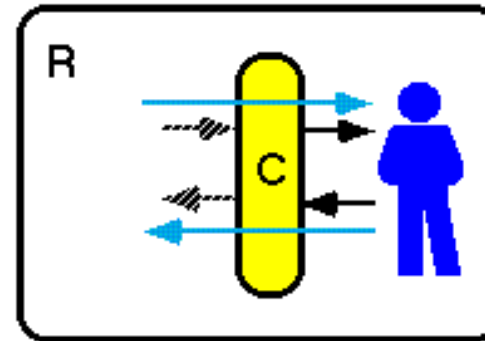
(d) Augmented Interaction

Rekimoto, J. and Nagao, K. 1995. The world through the computer: computer augmented interaction with real world environments. In *Proc. of the 8th Annual ACM Symposium on User interface and Software Technology. UIST '95*. ACM, New York, NY, 29-36.

Graphical User Interfaces

Digital

Physical

(a) GUI
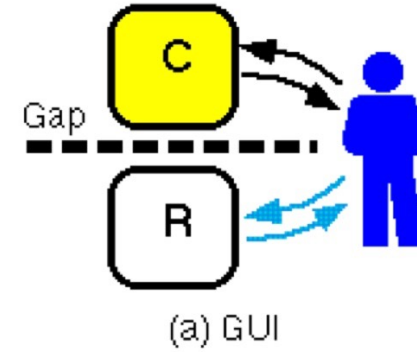
- Separation between real and digital worlds
  - WIMP (Windows, Icons, Menus, Pointer) metaphor

Ubiquitous Computing/IoT
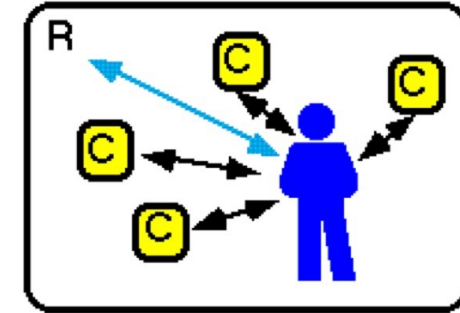
(c) Ubiquitous Computers

- Embed computing and sensing in real world
  - Smart objects, sensors, etc..

Virtual Reality
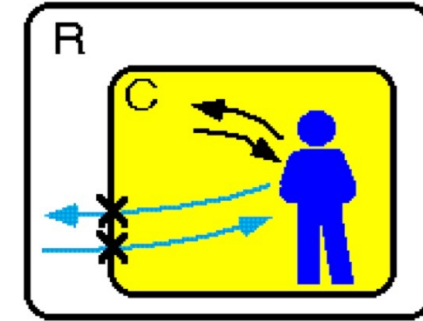
(b) Virtual Reality

- Users immersed in Computer Generated environment
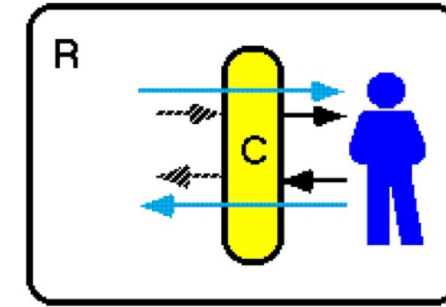 - HMD, gloves, 3D graphics, body tracking

Cave Automatic Virtual Enviroment (CAVE)

Concept first introduced at University of Illinois-Chicago for 1992 SIGGRAPH showcase

- Rear-project walls,
- Ceiling-projected floor
- Stereoscopic glasses
- Some identification of place and orientation.

Augmented Reality

(d) Augmented Interaction

- Virtual Images blended with the real world
  - See-through HMD, handheld display, viewpoint tracking, etc..

Augmented Reality in Science Fiction

1977 – Star Wars

Definitions:

- **Virtual reality (VR)** is a computer technology that uses Virtual reality headsets, sometimes in combination with physical spaces or multi-projected environments, to generate realistic images, sounds and other sensations that simulate a user's physical presence in a virtual or imaginary environment.

- **Augmented reality (AR)** is a live direct or indirect view of a physical, real-world environment whose elements are "augmented" by computer-generated or extracted real-world sensory input such as sound, video, graphics or GPS data.

# Definitions Cont'd:

- **Mixed reality (MR)**, sometimes referred to as hybrid reality, is the merging of real and virtual worlds to produce new environments and visualizations where physical and digital objects co-exist and interact in real time. Mixed reality takes place not only in the physical world or the virtual world, but is a mix of reality and virtual reality, encompassing both augmented reality and augmented virtuality via immersive technology.

- **Extended reality** (*XR*) is a term referring to all real-and-virtual combined environments and human-machine interactions generated by computer technology and wearables. It includes representative forms such as augmented reality (AR), mixed reality (MR) and virtual reality (VR) [1] and the areas interpolated among them. The levels of virtuality range from partially sensory inputs to immersive virtuality, also called VR.
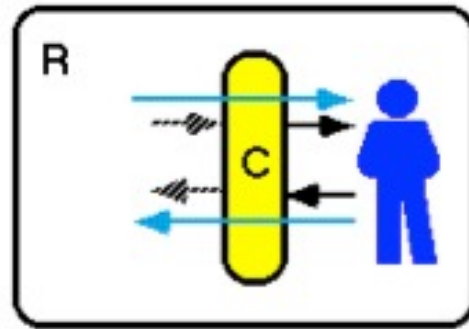
AR vs VR

	Virtual Reality *Replaces Reality*	**Augmented Reality** *Enhances Reality*
Scene Generation	Requires realistic images	Minimal rendering okay
Display Device	Fully immersive, wide field of view	Non-immersive, small field of view
Tracking	Low to medium accuracy is okay	The highest accuracy possible

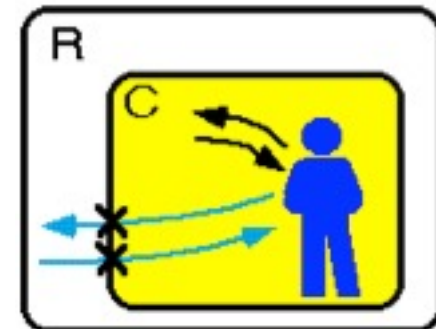# From Reality to Virtual Reality
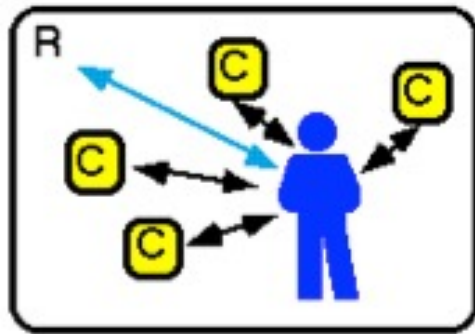
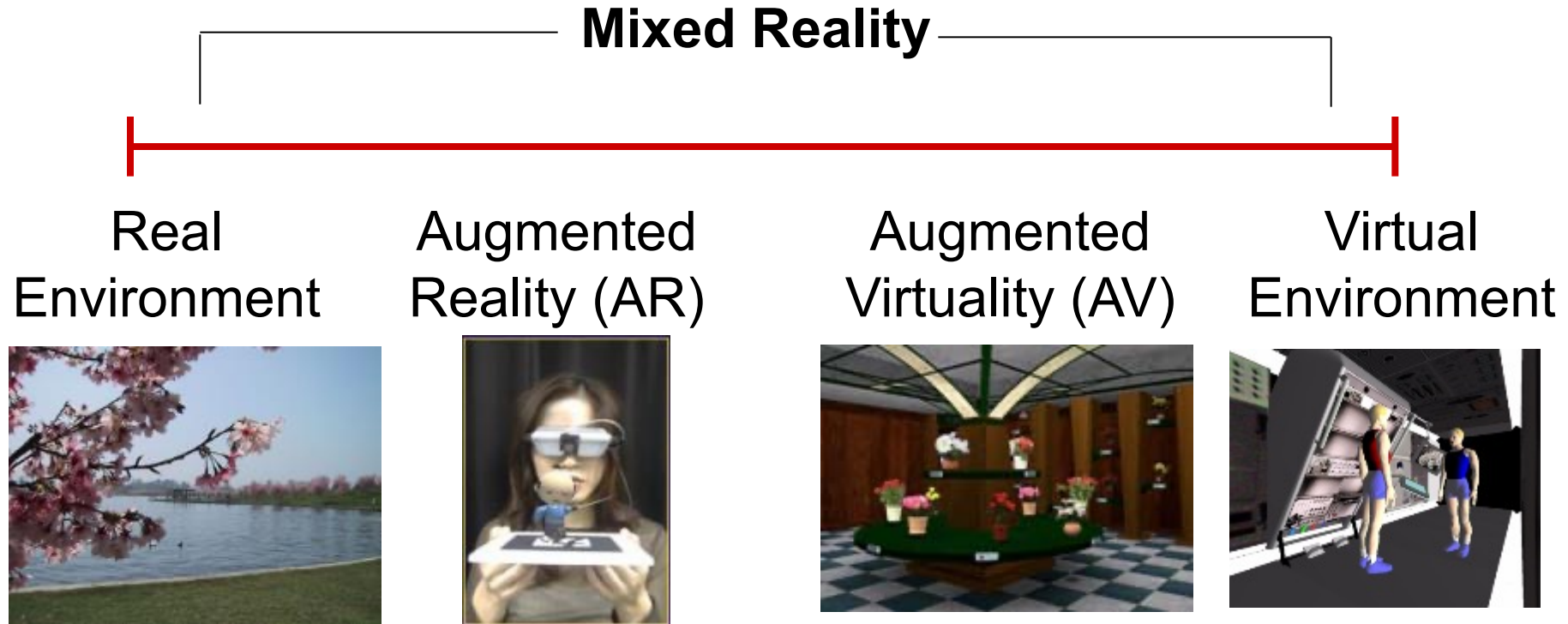Ubiquitous Computing   Augmented Reality   Virtual Reality

Real World   Virtual World

Milgram's Reality-Virtuality Continuum

"...anywhere between the extrema of the *virtuality continuum."*

Mixed Reality

Real Environment

Augmented Reality (AR)

Augmented Virtuality (AV)

Virtual Environment

Reality - Virtuality (RV) Continuum

P. Milgram and A. F. Kishino, Taxonomy of Mixed Reality Visual Displays IEICE Trans. on Info. and Systems, E77-D(12), pp. 1321-1329, 1994.

Virtual Reality Applications

- Phobia Therapy
- Military Training
- Entertainment

- Immersion & Presence

Figure 1. Virtual conference room used to treat fear of public speaking. (Used with permission, Virtually Better, LLC.)

Immersion & Presence

"**Immersion** refers to the objective level of sensory fidelity a VR system provides"

"**Presence** refers to a user's subjective psychological response to a VR system"

M. Slater "A Note on Presence Terminology", Presence-Connect, January 2003

Google Cardboard

https://vr.google.com/cardboard/
https://ecs.wgtn.ac.nz/Groups/HCI/CardBoardVR

Oculus Rift (Facebook/Meta)

https://www.oculus.com/rift-s/

Oculus Quest (Facebook/Meta)

https://www.oculus.com/quest/

HTC Vive

VIVE

https://www.vive.com

Microsoft Hololens

https://www.youtube.com/watch?v=eqFqtAJMtYE

Google Glass

GLASS

https://www.youtube.com/watch?v=ErpNpR3XYUw
https://www.youtube.com/watch?v=IessjPY9gwI

Magic Leap

https://www.magicleap.com/
https://www.youtube.com/watch?v=Y_XbInoyZMk

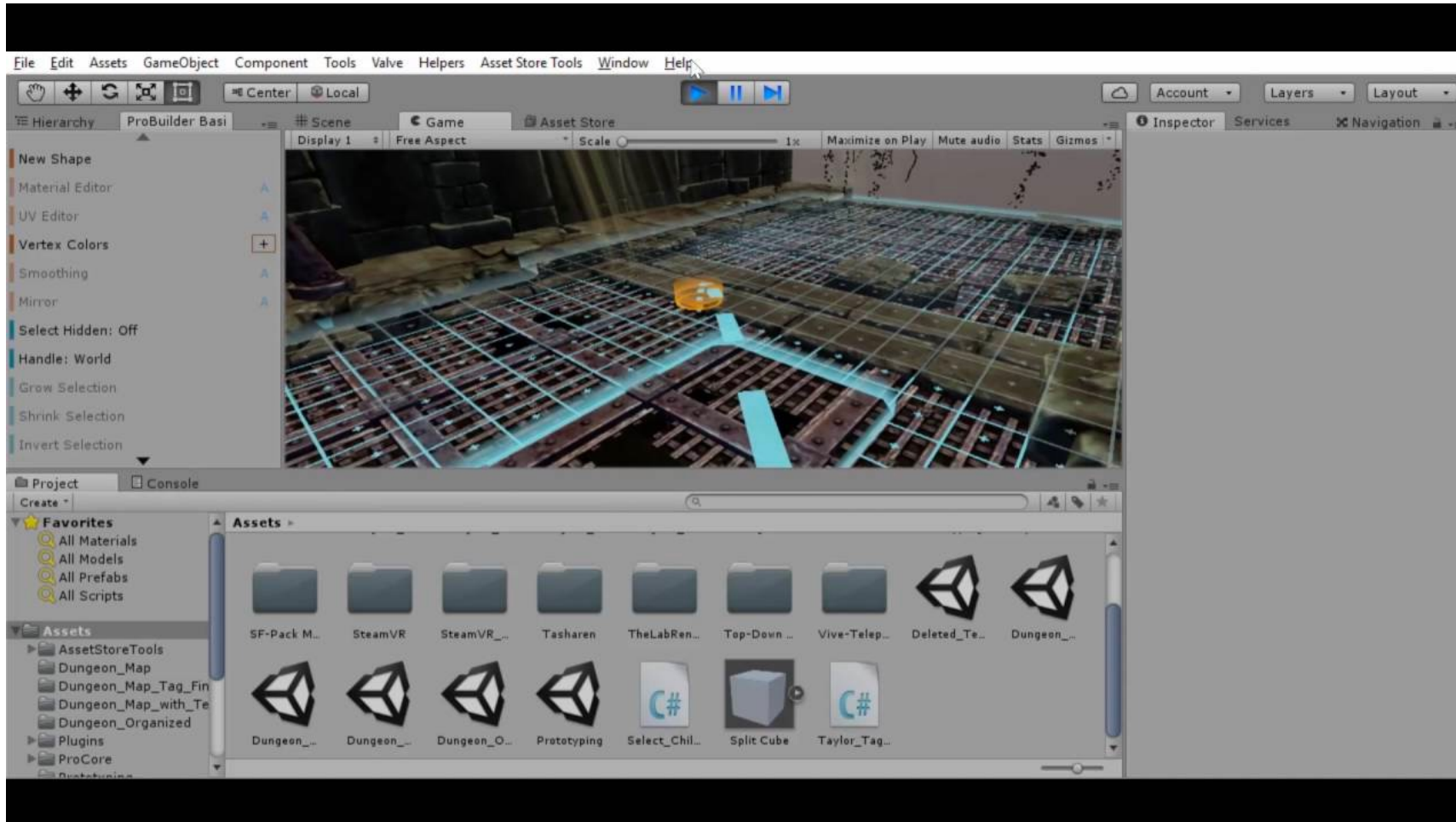# Apple Vision Pro

https://www.apple.com/apple-vision-pro/
https://www.youtube.com/watch?v=IY4x85zqoJM&ab_channel=Apple (1 min)
https://www.youtube.com/watch?v=TX9qSaGXFyg&ab_channel=Apple (9 mins)

Unity

https://unity.com/

Unreal Engine

https://www.unrealengine.com/
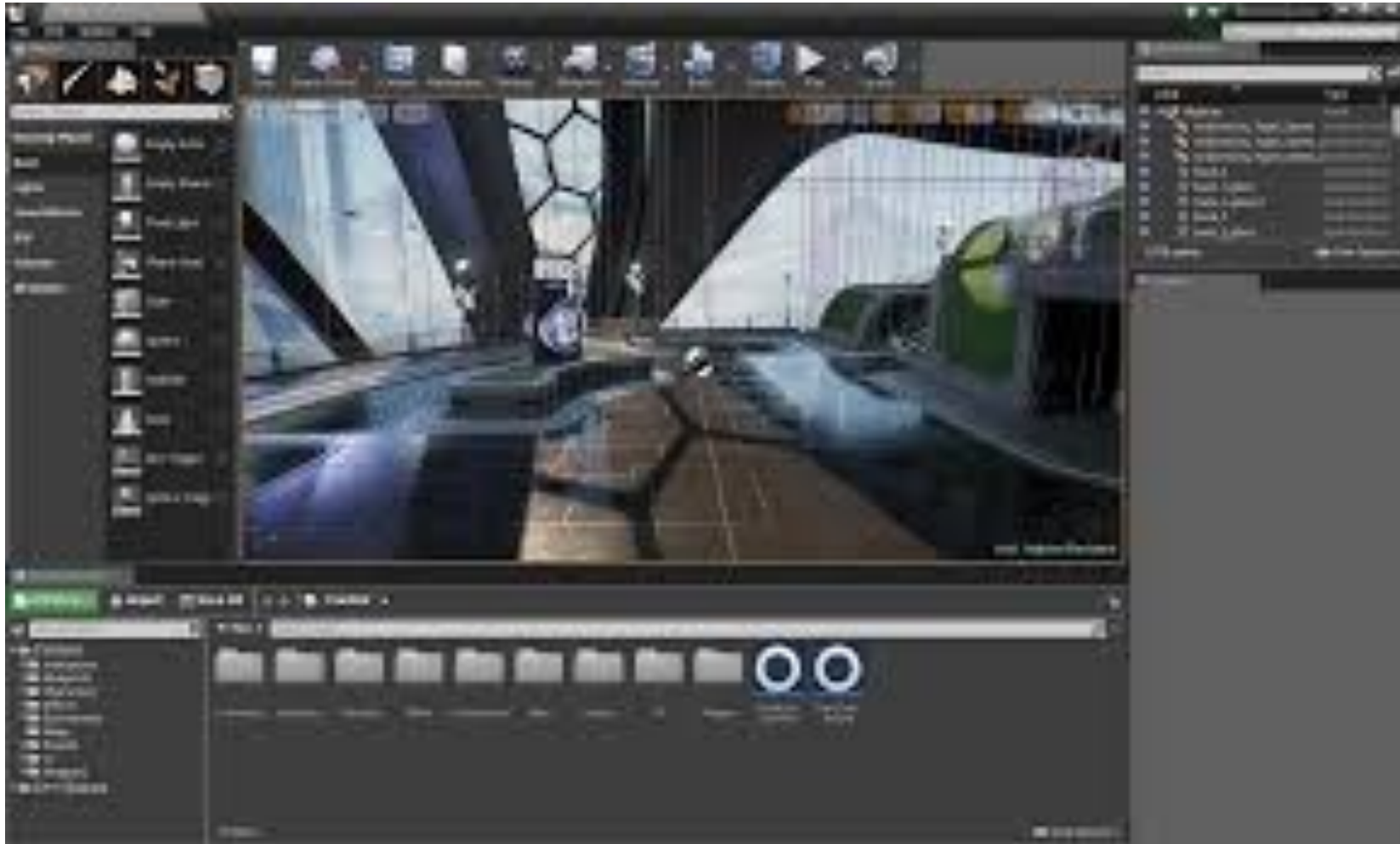
Resources

- **XR Workshop (Summer School):** https://sites.google.com/view/xrworkshop
- **Meetups:**
    - https://www.meetup.com/Augmented-Reality-Wellington/
    - https://www.meetup.com/auckland-xr/
- **NZ Labs:**
    - VUW HCI Group: https://ecs.wgtn.ac.nz/Groups/HCI/WebHome
    - Auckland - Empathic Computing Lab (Mark Billinghurst): http://empathiccomputing.org/
    - Canterbury - HITLab NZ (Rob Lindeman): http://www.hitlabnz.org/
    - Otago HCI Lab (Tobias Langlotz & Holger Regenbrecht): https://www.hci.otago.ac.nz/
- **Conferences:**
    - IEEE VR https://ieeevr.org/
    - IEEE ISMAR https://www.ismar.net/
    - ACM VRST https://vrst.acm.org/
    - ICAT-EGVE https://icat.vrsj.org/
    - ACM SIGGRAPH https://www.siggraph.org/
- **Education:** https://virtualrealityforeducation.com/resources/