Virtual Reality Design Processes

(For internal use only)

User Interactions

Yasser Malaika (Valve)

Common Interactions are: Object interactions, system commands & navigation

VR related terminology for input devices	Maps to
6 DOF (Degrees of Freedom):	Within Reach
Pointing	Reach & beyond
Hand Control	Activation elements (buttons, swiping etc.)
Ambient Invocation: things like voice	Indirect & infrequent
Subconscious (your location in space, direction, rotation, etc.)	Background

- Affordance: aspect of an object that hints at function
  - Abstract affordances are important in User Comfort
  - In a person's mind abstract affordances will lose out to concrete affordances
  - The more real the look of an affordance the higher the user expectations
  - If a gesture has meaning it can override the kinematic issues

User Interactions

- The ideal interaction set
  - https://www.youtube.com/watch?v=FheQe8rfIWQ&t=43s
  - The goal:
    - Natural & intuitive, gesture driven interactions

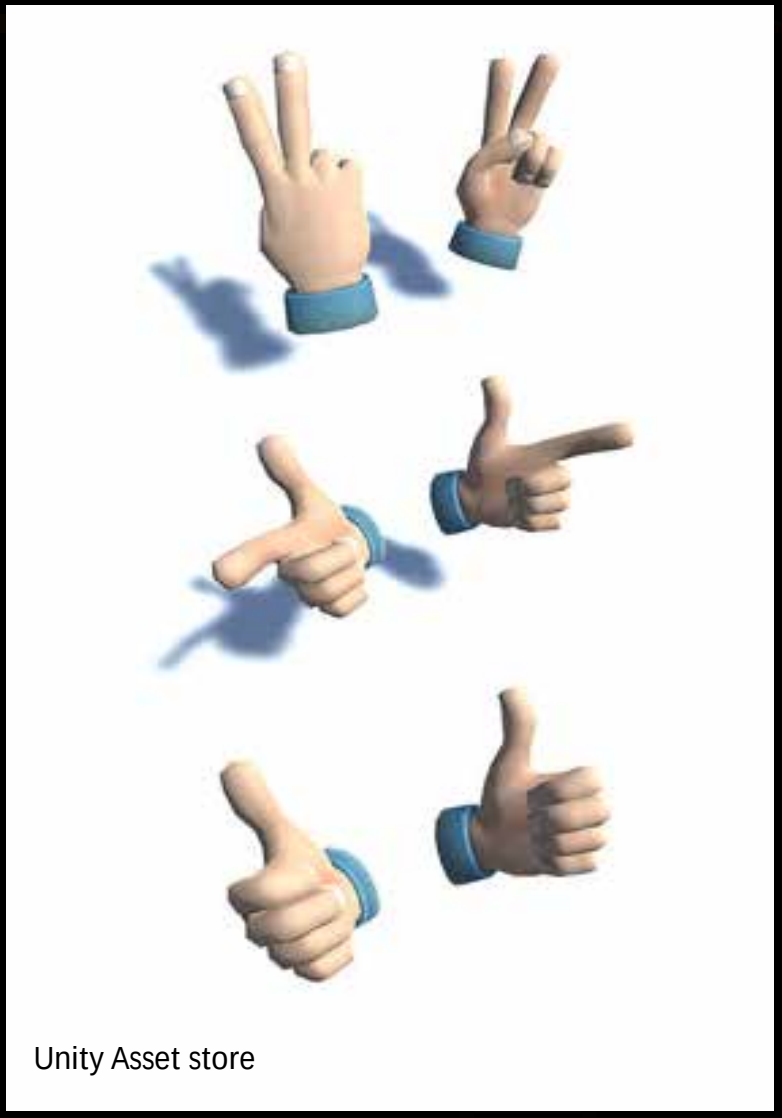
- Current state of interactions
  - https://www.youtube.com/watch?v=65u3W7wjXs0
  - The reality:
    - Limited input devices, limited range of motion, limited FOV, 2D interfaces in 3D
  - Another example: https://www.youtube.com/watch?v=FOTGv2WxhXQ&feature=emb_logo

Object Interactions: Selection

Yasser Malaika (Valve)

VR input systems map naturally to the human form

- Visual (looking around) maps to the head
- Movement maps to the legs
- Selection/input maps to the arms/hands
  - Uncanny Valley: When things appear human but not quite, it creates a revulsion in the person.
  - In VR it actually applies to yourself
    - Hands are the best example of this
- Don ‘t mix them up
  - Don’t use hands for movement
  - Head pointing/gaze for selection can be problematic
  - § There are exceptions, teleportation for example
    - § Technology is improving here



Unity Asset store

User Intent: How do we get their Input and give Feedback

Yasser Malaika (Valve)

Input devices are fairly consistent through the Vive, Rift/Quest and PSVR

- They offer 6 degrees of freedom and excellent 1 to 1 position tracking
- Give developers advantages
  - Able to target multiple platforms
  - Set conventions that will develop into standards
  - Allows the development cultural to borrow from each other quickly

There are a multitude of other devices out there

- Hand tracking
- Haptic feedback via gloves, and other wearables
- Foot devices
- Voice command systems

Object Interaction: Considerations when using the hands as input devices

Leapmotion.com: design best practices

Interactive elements should be scaled to the expected interaction (e.g. full hand or finger/pointer size).

- *One finger/pointer targets should be no smaller than 20 mm in real-world size.*
  - *This ensures the user can accurately hit the target without accidentally triggering targets next to it.*

Keep in mind that human hands naturally move in arcs, rather than straight lines.

Limit the number of gestures that users are required to learn.

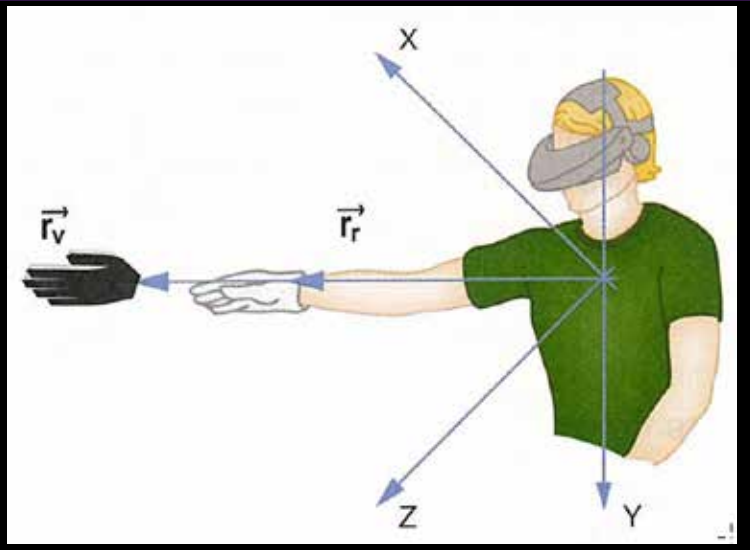
All interactions should have a distinct initiation and completion state.

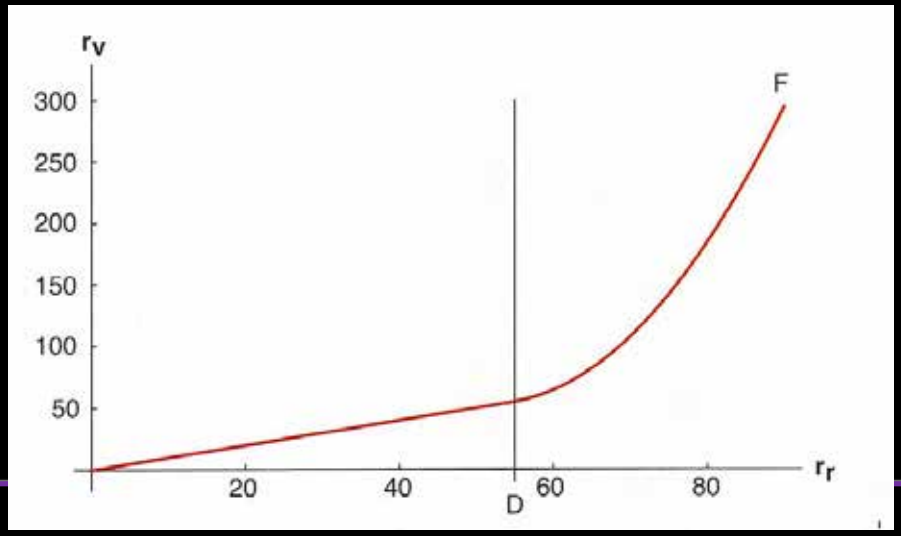
Ensure that users can interact with objects occluded by their hands.

Object Interactions: Selection methodologies

Arm Extension Selection

- Go Go Technique
  - Non-linear mapping between physical and virtual hand position
  - Local and distant regions (linear < D, non-linear > D)





Poupyrev, I., Billinghurst, M., Weghorst, S., & Ichikawa, T. (1996). The Go-Go Interaction Technique: Non-linear Mapping for Direct Manipulation in VR. *Proceedings of the ACM Symposium on User Interface Software and Technology,* 79-80.

Object Interactions: Selection methodologies

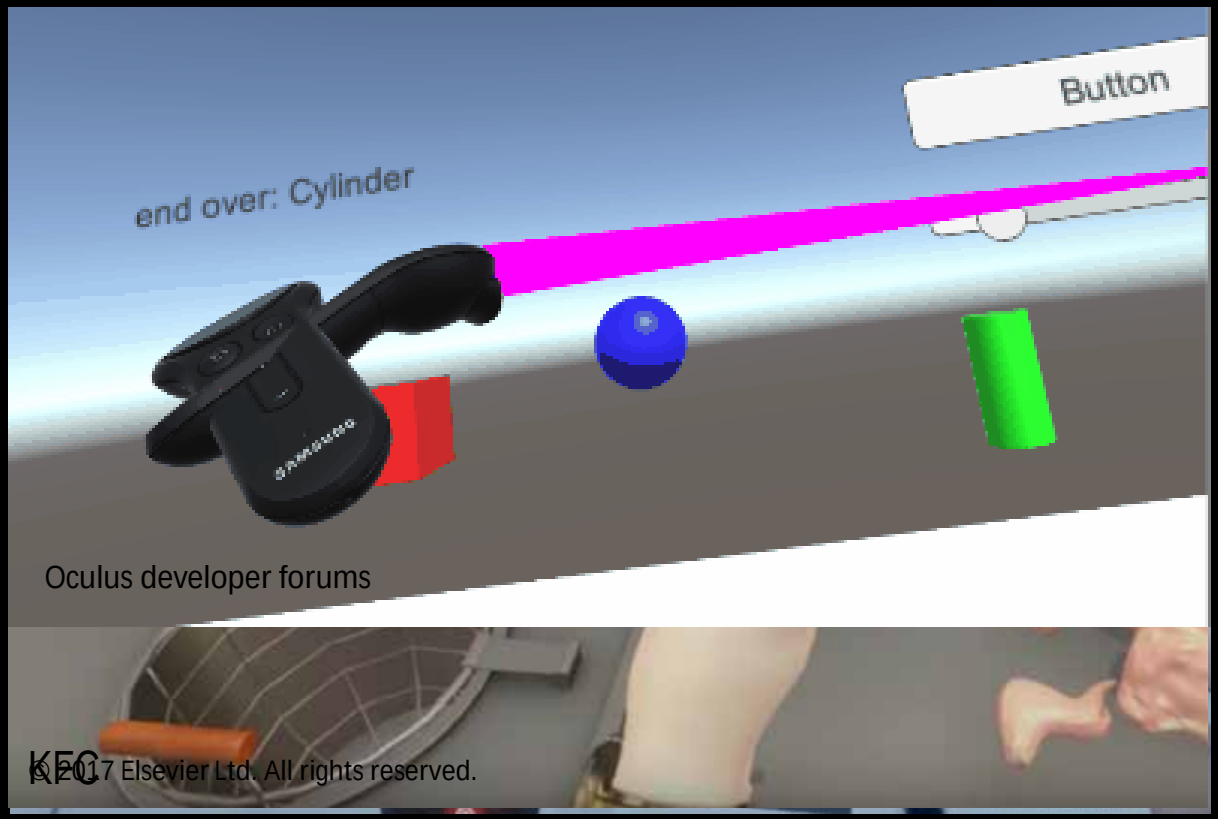
Touching

- Within reach (Local zone)
- Hands are naturally mapped
- You can also use a local pointer

- Occlusion
- Pretty much your standard 2D menu

Ray Cast (Mid/long range pointing)

- Accurate method to choose
- Paper Beast
  https://www.youtube.com/watch?v=R_ICEC30H3A
- Variants include
  - Cone casting
  - Snap to (for teleportation)

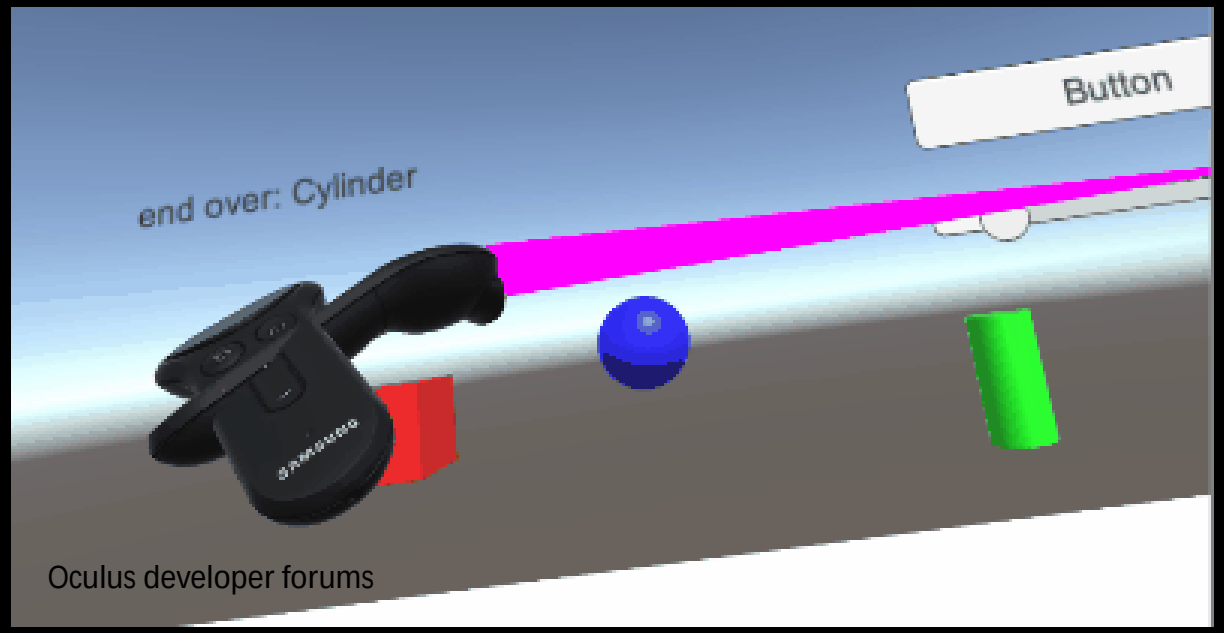


Oculus developer forums

Object Interactions: Selection Feedback

Feedback methods for selection available

- Graphical Change
- Voice
- Color Change



Feedback method for selection made

- Audio
- Voice
- Color Change
- Graphic Change

Object Interactions: Manipulation

- Manipulations, change:
  - Attachments
  - Position
  - Rotation
  - Size

- Examples: https://www.forrestthewoods.com/blog/the_vr_interface_of_dino_frontier/

VR Design Specifics: Examples

Hands & local interactions (reaching out to grab and touch):

Oculus' Lone Echo's 2: 1:40 https://www.youtube.com/watch?v=O6zIrKhNSM4

Affordances:

Job Simulator: Gourmet Chef https://www.youtube.com/watch?v=qZX_WVhL3eg

KFC Job Training: 2:00 https://www.youtube.com/watch?v=LritONRSiXc

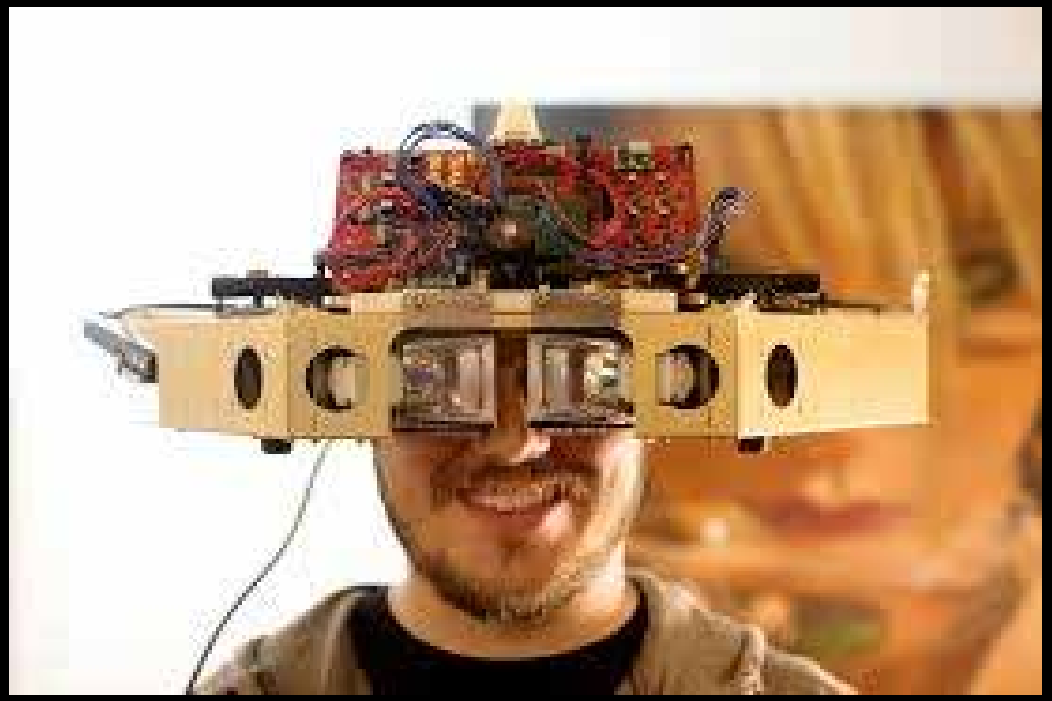
Augmented Reality Experiences and their Interactions

Window on the World (seen through a phone or tablet)

- Passive
  - Adding elements to a photo
- Active
  - Overlaying elements to the real world
    - Marker Driven
    - Non-Maker Driven

Immersive AR (seen through glasses or HMD)

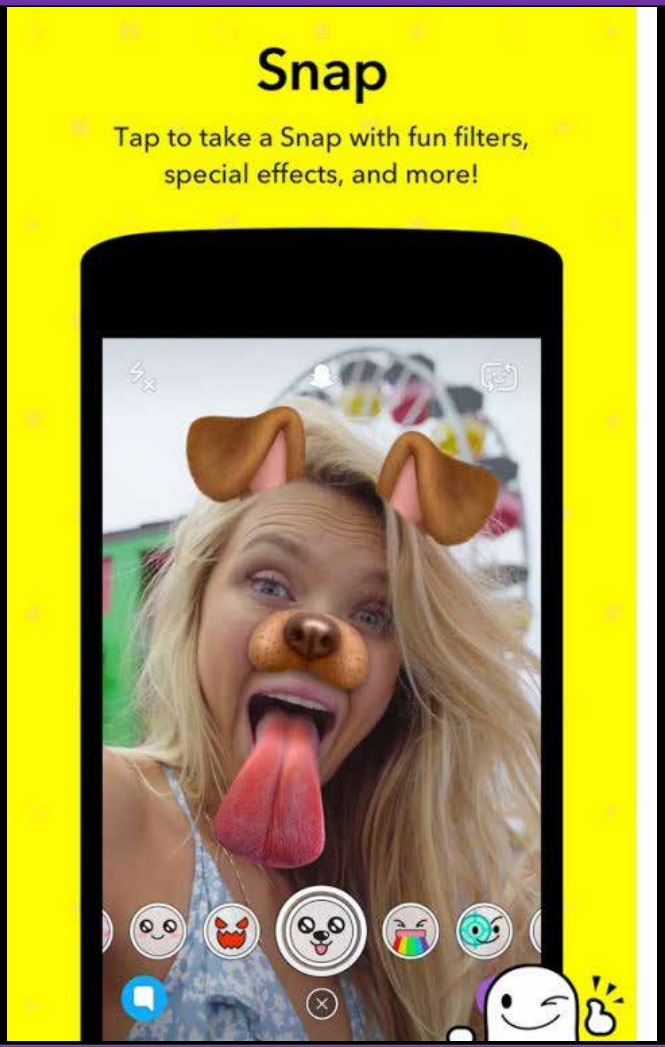
- Overlaid elements become part of the user's reality



Copyright Magic Leap: Prototype Headset

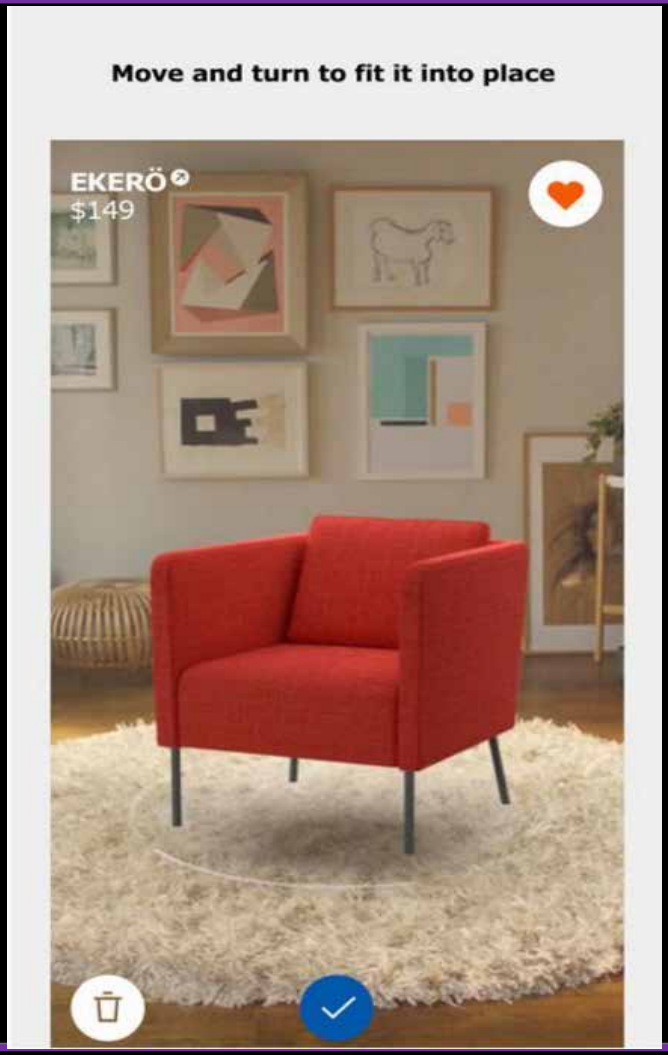
Augmented Reality UI: Passive WoW

- Audience is likely mass market
  - UI should be very simple
- Standard UI methods
  - Buttons
  - Swipes



Augmented Reality UI: Active WoW

- Audience is likely mass market
  - UI still needs to be very simple
  - Hide most of it, offer access to higher end users
- Markers and surfaces
  - Consideration for space and marker placement
- Standard UI methods
  - Buttons
  - Swipes
- Consideration for Error Detection
- Google’s path (Glasses to Lenses)



Augmented Reality UI: Immersive

- Very interesting opportunities
- Interface options are like VR
  - Hardware makes a difference
    - Hand and/or Eye Tracking
      - Interface via device
        - Tilt Five https://www.kickstarter.com/projects/tiltfive/holographic-tabletop-gaming
      - Interface via visual/auditory feedback
        - Hololens 2 https://www.cnet.com/videos/watch-microsoft-demo-hololens-2-at-mwc/
          - 3.55
      - Real World Tactile Feedback
- MR – interacting with an overlay of the real world https://www.youtube.com/watch?time_continue=10&v=sv6T-tg6RL4&feature=emb_logo