

Virtual Reality as a Medium: Changing Mechanics

Tom Forsyth

Software Architect, Oculus

June 22nd 2015



Tom Forsyth

- Graphics drivers @ 3Dlabs
- Game graphics @ Muckyfoot
 - Urban Chaos
 - Startopia
 - Blade 2
- Animation middleware: Granny3D @ RAD Game Tools
- Instruction set design on Larrabee / Xeon Phi @ intel
- VR research @ Valve
 - VR versions of Team Fortress 2 & Half Life 2
- Software Architect @ Oculus
 - All things graphics
 - Distortion & calibration, interaction with lens design
 - Best practices; dev.rel. support; psychology

VR is awesome!



VR is awesome!



VR is awesome!



VR is awesome!



VR is awesome!



VR is awesome!



VR is awesome!

This is a conference about gameplay, not graphics.
So far, VR has mostly been experiences
or games ported from existing media.
And sure, many of those are AWESOME in VR!

VR is awesome!

This is a conference about gameplay, not graphics.

So far, VR has mostly been experiences or games ported from existing media.

And sure, many of those are AWESOME in VR!

We have yet to see many truly VR-native titles

So what will they look like?

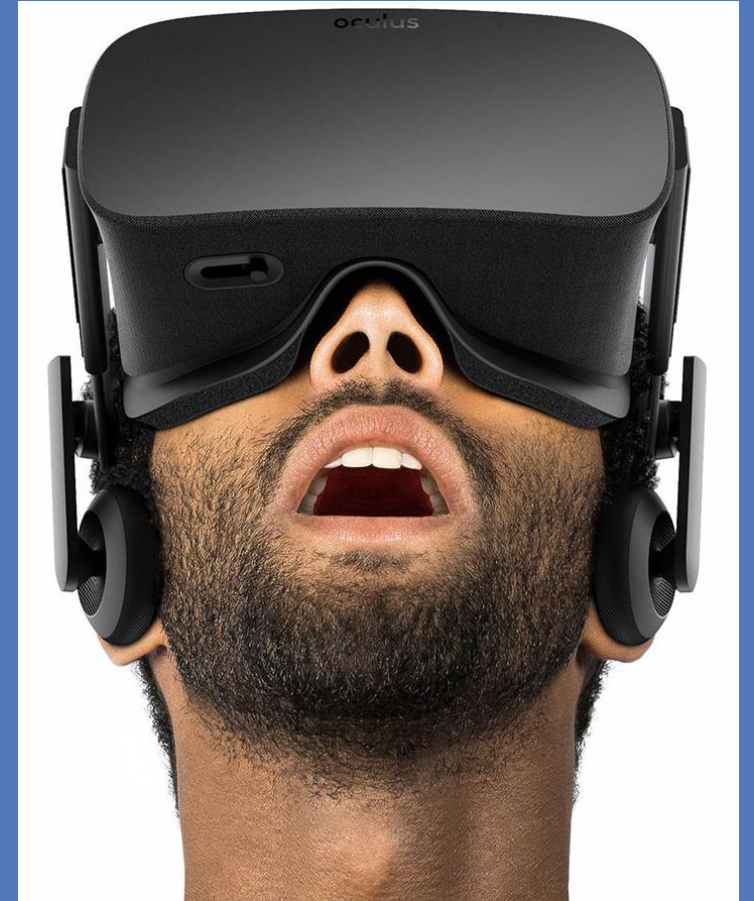
What are the unique gameplay mechanics that only VR can offer?

Topics

- Current state of hardware
- Game mechanics in the new medium
- Experiences to try
- Conclusions

Current state of hardware

- Oculus Rift consumer version, early 2016
 - 2160x1200, 90Hz screen
 - ~100 degree stereo FOV



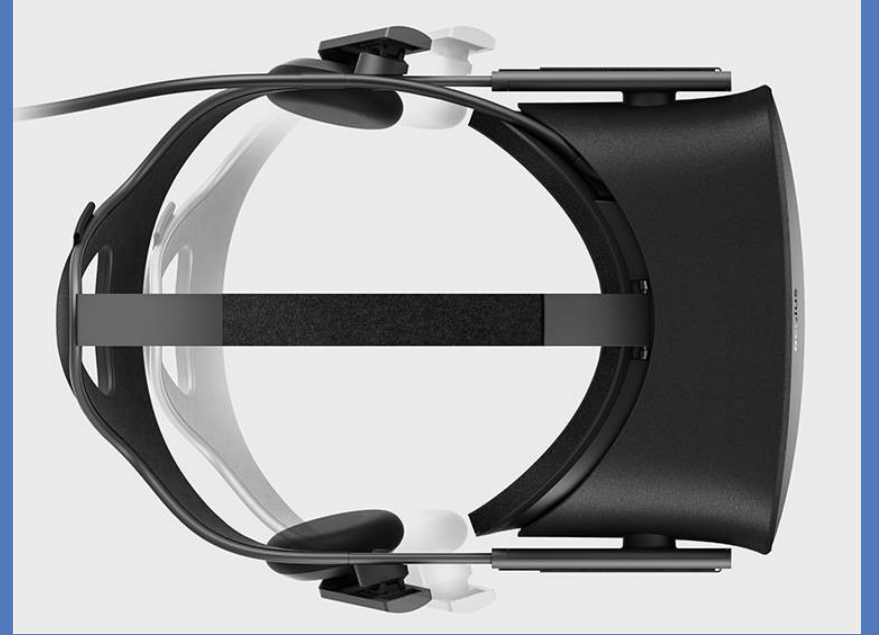
Current state of hardware

- Oculus Rift consumer version, early 2016
 - 2160x1200, 90Hz screen
 - ~100 degree stereo FOV
- Sensor Fusion tracking
 - 1kHz Inertial Measurement Unit (rotation, acceleration)
 - External camera watching constellation of LEDs (absolute position)



Current state of hardware

- Oculus Rift consumer version, early 2016
 - 2160x1200, 90Hz screen
 - ~100 degree stereo FOV
- Sensor Fusion tracking
 - 1kHz Inertial Measurement Unit
 - External camera watching constellation of LEDs
- Integrated headphones, calibrated for HRTF/binaural sound



Current state of hardware

- Oculus Rift consumer version, early 2016
 - 2160x1200, 90Hz screen
 - ~100 degree stereo FOV
- Sensor Fusion tracking
 - 1kHz Inertial Measurement Unit
 - External camera watching constellation of LEDs
- Integrated headphones
- Wireless Xbox One gamepad
 - For more “traditional” games



Current state of hardware

- Oculus Rift consumer version, early 2016
 - 2160x1200, 90Hz screen
 - ~100 degree stereo FOV
- Sensor Fusion tracking
 - 1kHz Inertial Measurement Unit
 - External camera watching constellation of LEDs
- Integrated headphones
- Wireless Xbox One gamepad
- Oculus Touch wireless tracked controllers
 - Thumb stick, buttons and triggers
 - Same tracking system as the HMD



Game Mechanics

- Movement & locomotion
- Less cinematography
- Perception of space and scale
- Pacing and being kind to your user
- Spatial sound
- Input methods

Movement & locomotion

- Fundamentally difficult in VR
 - Not a “bug” – better technology won’t help
- When eyes and ears disagree, people get sick
 - Eyes say you are running around
 - Ears say you’re sitting at a desk

Movement & locomotion

- Fundamentally difficult in VR
- When eyes and ears disagree, people get sick
- Be very careful with stairs
 - Some people have extra big problems
 - Elevators are (surprisingly) better
- No clear solution
 - Same problem as seasickness, and we haven't solved that either
 - Can people get used to it?
 - Will kids brought up with VR never have the problem?

Movement & locomotion

- Avoid acceleration
 - Inner ear senses acceleration, not constant speed
 - Constant linear motion works well for most people
 - Instant changes in speed are better than gradual ones (surprising!)

Movement & locomotion

- Avoid acceleration
 - Inner ear senses acceleration, not constant speed
 - Constant linear motion works well for most people
 - Instant changes in speed are better than gradual ones (surprising!)
- Literal “blink” transitions
 - Render black borders top and bottom coming together
 - Do it fast enough and some people don’t even see them!
 - Combine with teleportation

Movement & locomotion

- VR rooms
 - How many people will have one?
 - Limited useful space
 - Safety concerns
- Treadmills
 - Don't actually solve the problem!
 - Your ears still aren't actually moving
- Motion platforms
 - Only works for cars & aircraft, and expensive

Less cinematography

- Much cinematic language vanishes in VR
 - The camera is the player
 - Cinematic effects are literally moving the player's head!
 - Maybe in time audiences will learn the same detachment?

Less cinematography

- Much cinematic language vanishes in VR
- Camera rotation
 - Never
 - Taking control from the user causes acute nausea

Less cinematography

- Much cinematic language vanishes in VR
- Camera rotation – no good terribad awful
- Camera translation
 - Use sparingly, if at all
 - Especially unexpected motion
 - Try to signal it beforehand

Less cinematography

- Much cinematic language vanishes in VR
- Camera rotation – no good terribad awful
- Camera translation – be very careful
- Focus pulls
 - Of limited use in games already – cutscenes only
 - Even more annoying in VR
 - Though not particularly nauseating

Less cinematography

- Much cinematic language vanishes in VR
- Camera rotation – no good terribad awful
- Camera translation – be very careful
- Focus pulls – of limited use
- Framing
 - There's no frame in VR!
 - Force with a prop e.g. window/door?

Less cinematography

- Much cinematic language vanishes in VR
- Camera rotation – no good terribad awful
- Camera translation – be very careful
- Focus pulls – of limited use
- Framing – needs a prop
- High/low camera angles
 - Implies player is crouching or flying
 - Low angles especially feel really odd
 - Player is probably not focused on what you're trying to say with the angle!

Less cinematography

- Much cinematic language vanishes in VR
- Camera rotation – no good terribad awful
- Camera translation – be very careful
- Focus pulls – of limited use
- Framing – needs a prop
- High/low camera angles – player contortions
- Cuts
 - Many fast cuts cause disorientation
 - Consider using “blink” cuts

Perception of space and scale

Perception of space and scale

- Inter-Pupillary Distance (IPD) provides a yardstick
 - Also size of head/neck motion

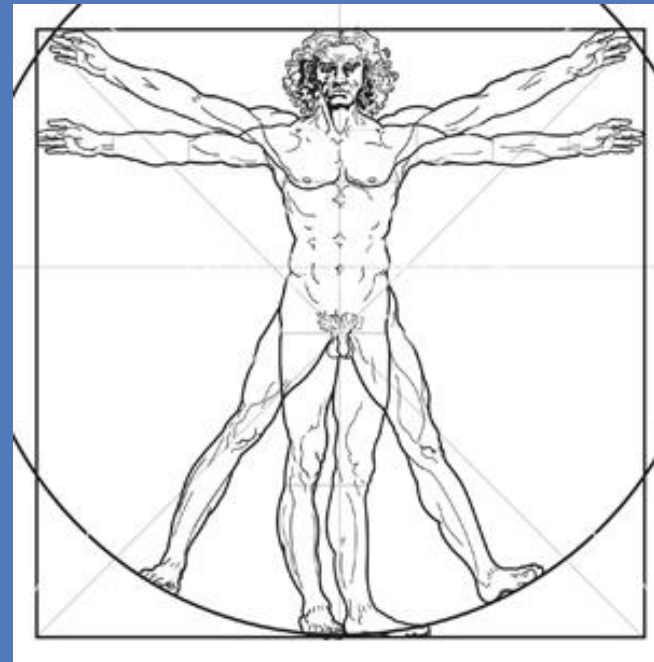


Perception of space and scale

- Inter-Pupillary Distance (IPD) provides a yardstick
- Inter-Camera Distance (ICD) determines scale of the virtual world
 - Changing ICD makes the world larger or smaller
 - Must scale neck motion the same amount or you get nausea
 - It is NOT good at making the user feel taller or shorter

Perception of space and scale

- Example – WH40k Space Marines are ~8 feet tall



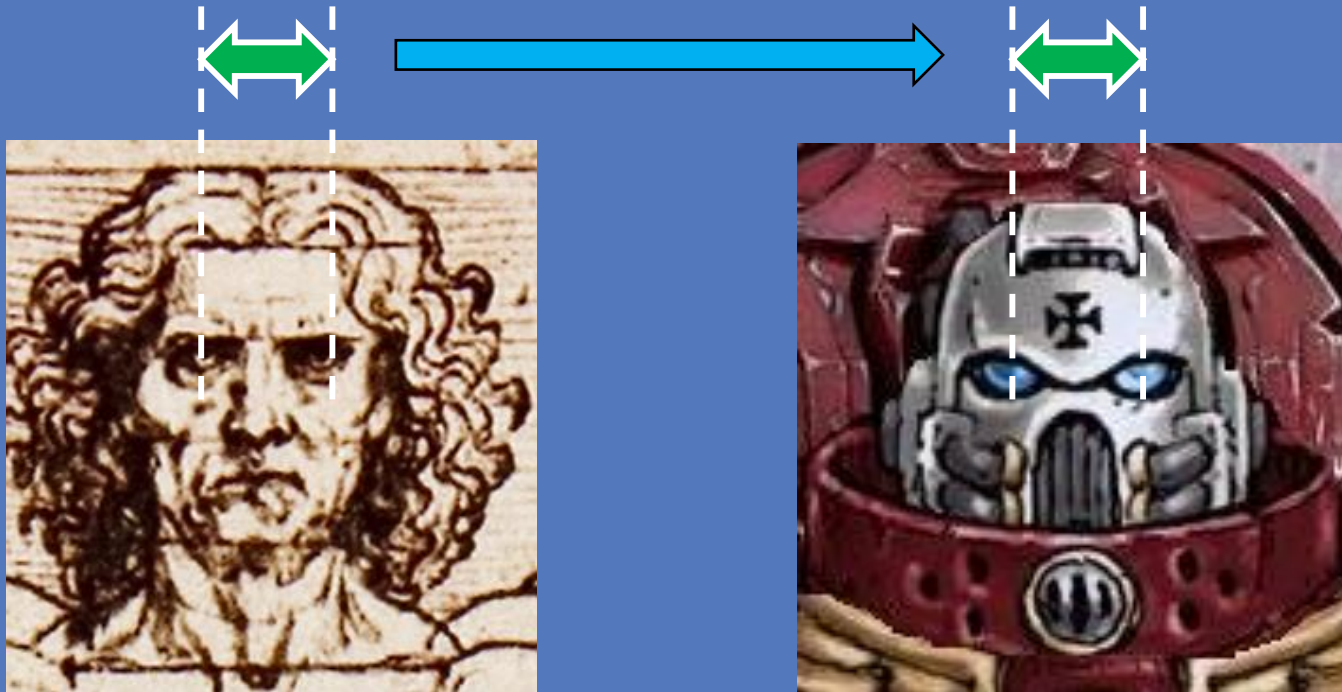
Perception of space and scale

- Average human IPD is around 65mm
- So by math, Space Marine's IPD is probably around 90mm?



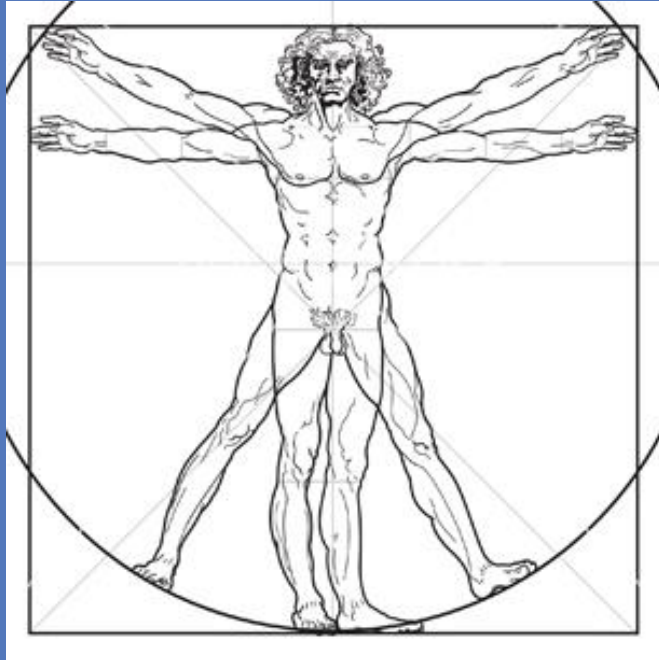
Perception of space and scale

- But if you move the virtual cameras to 90mm, you don't feel big!
- Instead, the world feels small



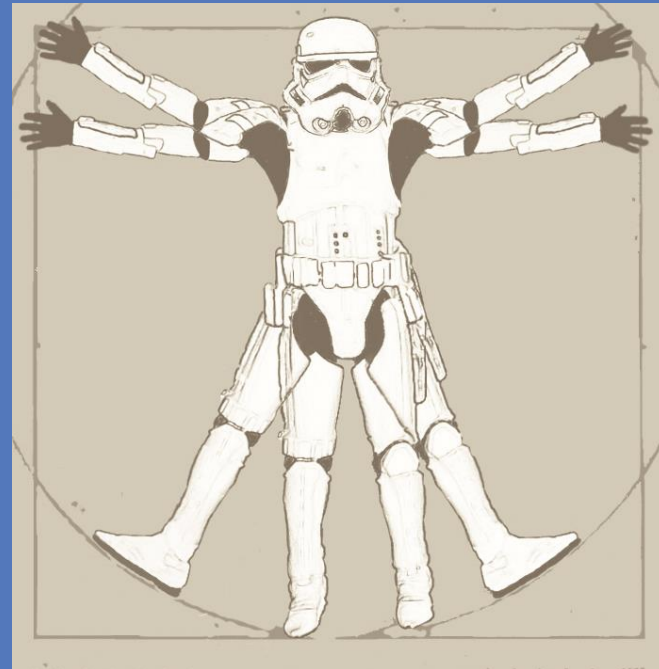
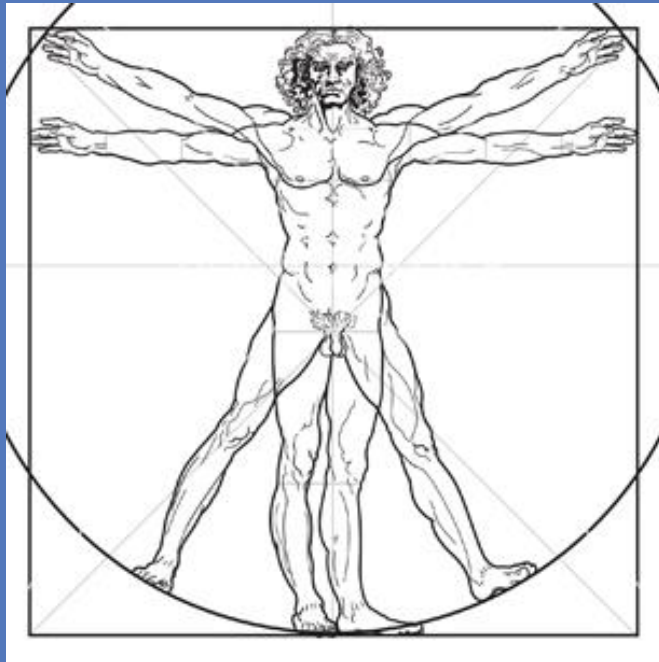
Perception of space and scale

- So instead of feeling huge...



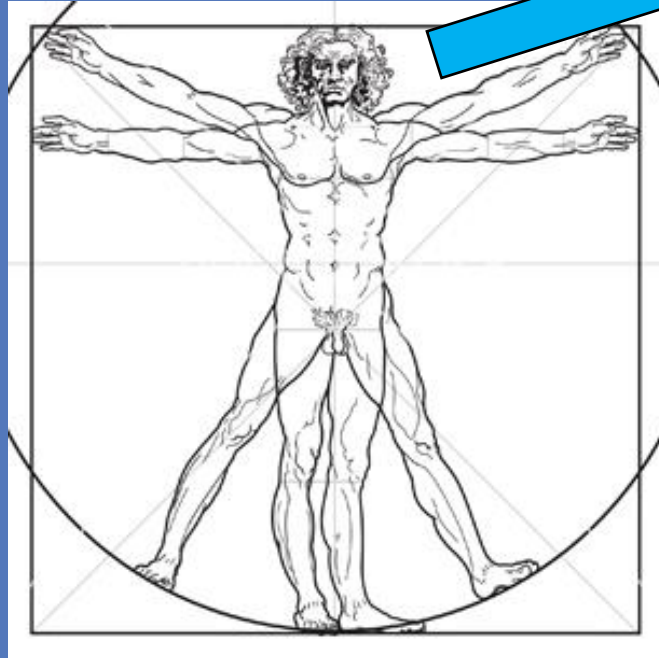
Perception of space and scale

- So instead of feeling huge...
- You just feel like yourself in a suit



Perception of space and scale

- Instead, keep your own IPD
- And stick that head 8 foot up



Perception of space and scale

- Inter-Pupillary Distance (IPD) provides a yardstick
- Inter-Camera Distance (ICD) determines scale of the virtual world
 - Scale neck motion the same amount
- Moving the cameras higher or lower off the ground works
 - People feel taller or shorter
 - Useful when playing children, yeti, giant robots, etc
 - Or playing known characters, e.g. James Bond, Bilbo Baggins, Godzilla

Perception of space and scale

- Inter-Pupillary Distance (IPD) provides a yardstick
- Inter-Camera Distance (ICD) determines scale of the virtual world
 - Scale neck motion the same amount
- Moving the cameras higher or lower off the ground works
 - People feel taller or shorter
 - Useful when playing children, yeti, giant robots, etc
 - Or playing known characters
- What does this mean for motion controls?
 - Swords/guns/equipment

Perception of space and scale

- Large people/creatures are viscerally intimidating



Perception of space and scale

- Large people/creatures are viscerally intimidating
 - Growing the player to match makes things feel “epic”



Perception of space and scale

- Large people/creatures are viscerally intimidating
 - Growing the player to match makes things feel “epic”
- Dangerous objects
 - Heavy masses hanging overhead
 - Fast-moving rocks/machinery/robots nearby

Perception of space and scale

- Large people/creatures are viscerally intimidating
 - Growing the player to match makes things feel “epic”
- Dangerous objects
 - Heavy masses hanging overhead
 - Fast-moving rocks/machinery/robots nearby
- You can invoke primal fears
 - Falling a long way, or onto dangerous surfaces
 - Tight spaces
 - Submersion
 - But beware of those with real phobias



Pacing and being kind to your user

- VR is highly involving and emotive
 - It demands your attention
 - Maintaining emotional distance is hard
 - Usual external distractions (drinks, family, internet) often missing/masked

Pacing and being kind to your user

- VR is highly involving and emotive
 - It demands your attention
 - Maintaining emotional distance is hard
 - Usual external distractions (drinks, family, internet) often missing/masked
- Full-pace VR can be very draining
 - Team Fortress 2 VR is technically sound
 - But it's terrifying to play!



Pacing and being kind to your user

- VR is highly involving and emotive
 - It demands your attention
 - Maintaining emotional distance is hard
 - Usual external distractions (drinks, family, internet) often missing/masked
- Full-face VR can be very draining
- Use pacing techniques from cinema
 - Similarly captive audience
 - We expect similar play times in VR

Pacing and being kind to your user

- VR is highly involving and emotive
 - It demands your attention
 - Maintaining emotional distance is hard
 - Usual external distractions (drinks, family, internet) often missing/masked
- Full-face VR can be very draining
- Use pacing techniques from cinema
 - Similarly captive audience
 - We expect similar play times in VR
- Where possible, allow players to progress at their own pace
 - Although removing that control can also be a useful dramatic tool!

Spatial sound

“Creates a totally immersive, realistic audio experience [...] it will enhance player's audio/visual game play experience.

It provides additional audio sources and includes the ability to mimic real-world environments with reflections and occlusions [...] This will take the immersive audio experience to new heights.”

Spatial sound

“Creates a totally immersive, realistic audio experience [...] it will enhance player's audio/visual game play experience.

It provides additional audio sources and includes the ability to mimic real-world environments with reflections and occlusions [...] This will take the immersive audio experience to new heights.”

Epic Games press release, Aureal A3D technology, 1998

Spatial sound

- Great spatial sound tech has been around for a long time
 - But most users do not have a well set-up system
 - Significant numbers have left and right swapped!
 - Sound designers cannot *rely* on good spatial awareness

Spatial sound

- Great spatial sound tech has been around for a long time
 - But most users do not have a well set-up system
 - Significant numbers have left and right swapped!
 - Sound designers cannot *rely* on good spatial awareness
- With VR, we finally have progress
 - Reliable hardware – stereo headphones can be assumed
 - Rift has speakers with known frequency response
 - Known head position – HRTF can actually work well
 - Spatial sound built into many VR SDKs



Spatial sound

- Great spatial sound tech has been around for a long time
 - But most users do not have a well set-up system
 - Significant numbers have left and right swapped!
 - Sound designers cannot *rely* on good spatial awareness
- With VR, we finally have progress
 - Reliable hardware – stereo headphones can be assumed
 - Rift has speakers with known frequency response
 - Known head position – HRTF can actually work well
 - Spatial sound built into many VR SDKs
- Maybe now can it actually be a game mechanic?



Input methods

- Most VR companies have “wands”
 - Oculus Touch, Sony Move
 - Valve Vive, Sixsense STEM
 - Position + orientation of palm
 - Sticks, buttons and triggers



Input methods

- Most VR companies have “wands”
 - Oculus Touch, Sony Move
 - Valve Vive, Sixsense STEM
 - Position + orientation of palm
 - Sticks, buttons and triggers
- Some have “grip” sensors
 - Users find “grab and hold” a very natural action
 - Sculpting user-generated content is very compelling in VR
- Gestures – “over there”, “follow me”, etc
- Low weight and no haptics means swords, climbing, etc is harder



Input methods

- Conventional game controllers
 - Still very useful when you need lots of buttons
 - Good for third-person action games
 - Surprisingly compelling in VR
 - Wheels & flightsticks

Input methods

- Conventional game controllers
 - Still very useful when you need lots of buttons
 - Good for third-person action games
 - Surprisingly compelling in VR
 - Wheels & flightsticks
- Hand tracking
 - Limited input channels
 - Orientation of palm
 - ~10 gestures, imprecise and slow
 - Actually worse than a wand!
 - Without haptics, fine control is hard

Try these VR experiences...

- So you want to try some VR...

Try these VR experiences...

- Elite Dangerous
 - Spaceflight is amazing in VR
 - Highly polished game
 - Excellent VR integration



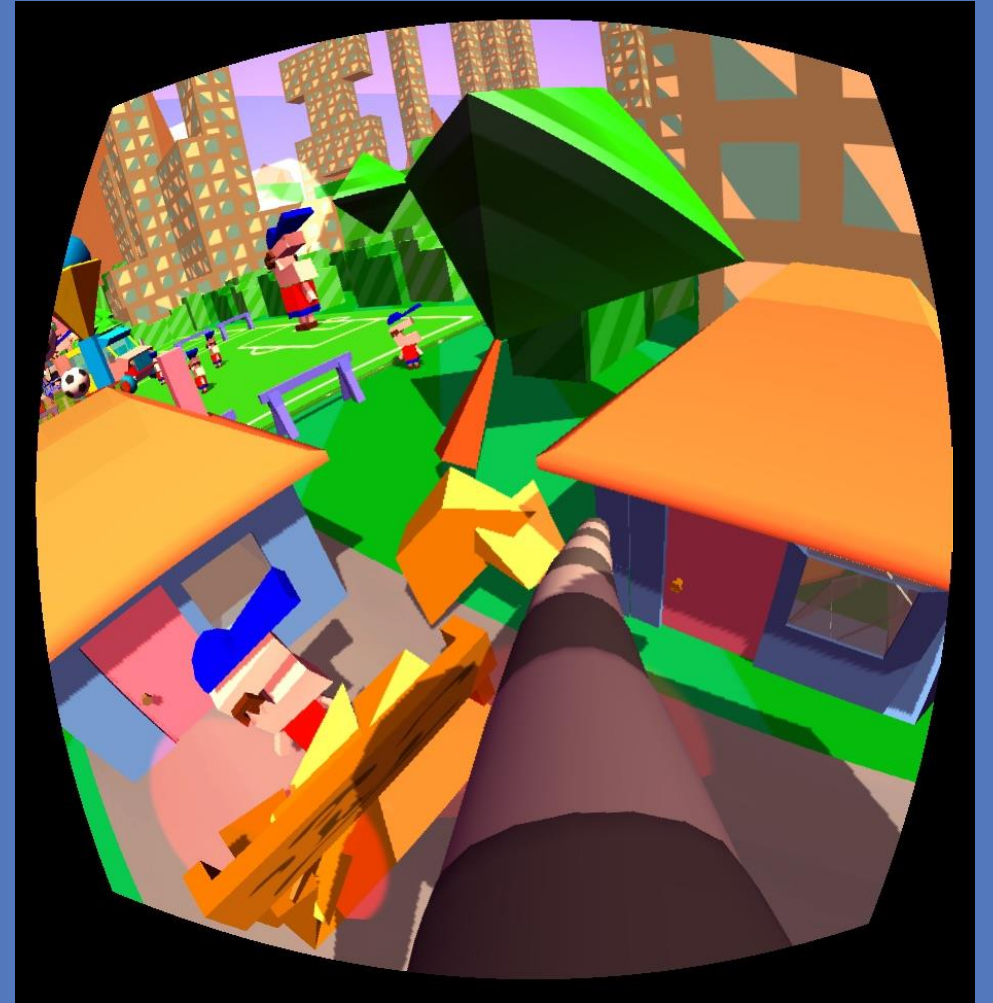
Try these VR experiences...

- Elite Dangerous
- Euro Truck Simulator 2
 - Delivering goods in Europe
 - Curiously compelling
 - VR completes the zen



Try these VR experiences...

- Elite Dangerous
- Euro Truck Simulator 2
- Dumpy, Going Elephants
 - Smash things with your trunk!
 - Novel input scheme
 - Gets people looking around



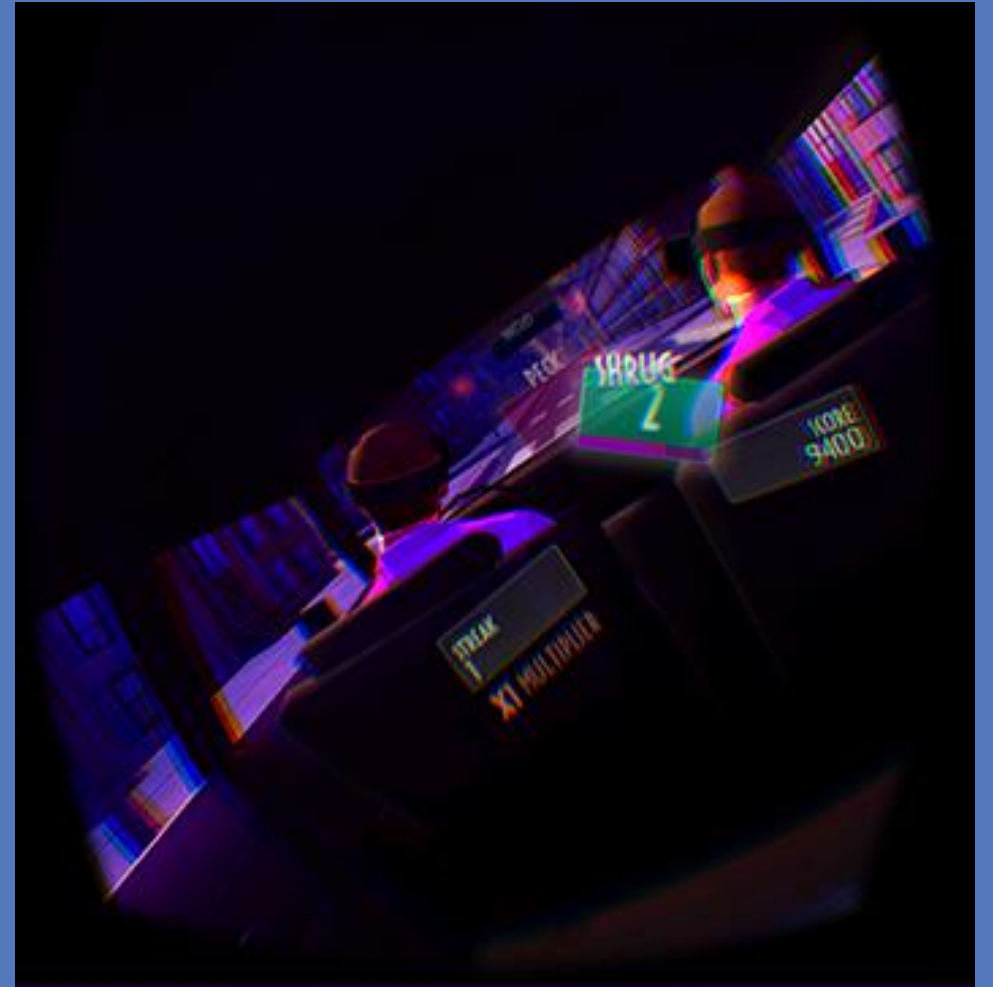
Try these VR experiences...

- Elite Dangerous
- Euro Truck Simulator 2
- Dumpy, Going Elephants
- Classroom Aquatic
 - Cheat to pass the test
 - Sneak looks at other desks
 - But don't get caught!



Try these VR experiences...

- Elite Dangerous
- Euro Truck Simulator 2
- Dumpy, Going Elephants
- Classroom Aquatic
- A Night at the Roculus
 - Nod/shake your head to the beat



Conclusions

Conclusions

- VR can be very personal
 - Immediate sense of being there – “presence”
 - Scale is conveyed very intuitively
 - Implicit emotional attachment
 - Can be a blessing and a curse

Conclusions

- VR can be very personal
 - Immediate sense of being there – “presence”
 - Scale is conveyed very intuitively
 - Implicit emotional attachment
 - Can be a blessing and a curse
- Most cinematic tricks don't work well
 - Will audiences become more sophisticated in future?

Conclusions

- VR can be very personal
 - Immediate sense of being there – “presence”
 - Scale is conveyed very intuitively
 - Implicit emotional attachment
 - Can be a blessing and a curse
- Most cinematic tricks don't work well
 - Will audiences become more sophisticated in future?
- More expressive inputs
 - Or will they go the way of the Wiimote?

Conclusions

- VR can be very personal
 - Immediate sense of being there – “presence”
 - Scale is conveyed very intuitively
 - Implicit emotional attachment
 - Can be a blessing and a curse
- Most cinematic tricks don't work well
 - Will audiences become more sophisticated in future?
- More expressive inputs
 - Or will they go the way of the Wiimote?
- Still looking for the “unique killer app” that forces people to get VR



Questions?

developer.oculus.com
tom.forsyth@oculus.com



Further reading

Oculus dev area:

GDC / Connect 2014:
Rift

Best Practices Guide

Developing VR Experiences with the Oculus