

Empower Design, Construction and Beyond with Virtual Reality



Presented by
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Agenda

- VR Development and Applications
- AEC VR Development Focus
- Methods of VR Presentation
- Introduction to AEC VR Software
- Architectural VR Design Review
- VR for Construction
- Future Development
- Summary

Spatial Representation Challenge

- Photorealistic images and walkthrough videos are widely used for visualization that lack “I am there” experience and interaction
- Prototype, scale model, physical model are used to validate design which are expensive and lack one to one real scale experience
- Dangerous environment and complicated process are not easy to replicate by just watching training videos
- Use images and word description to explain procedures that can be difficult to understand



Rendered image



Scale Model



Video



Image & Word

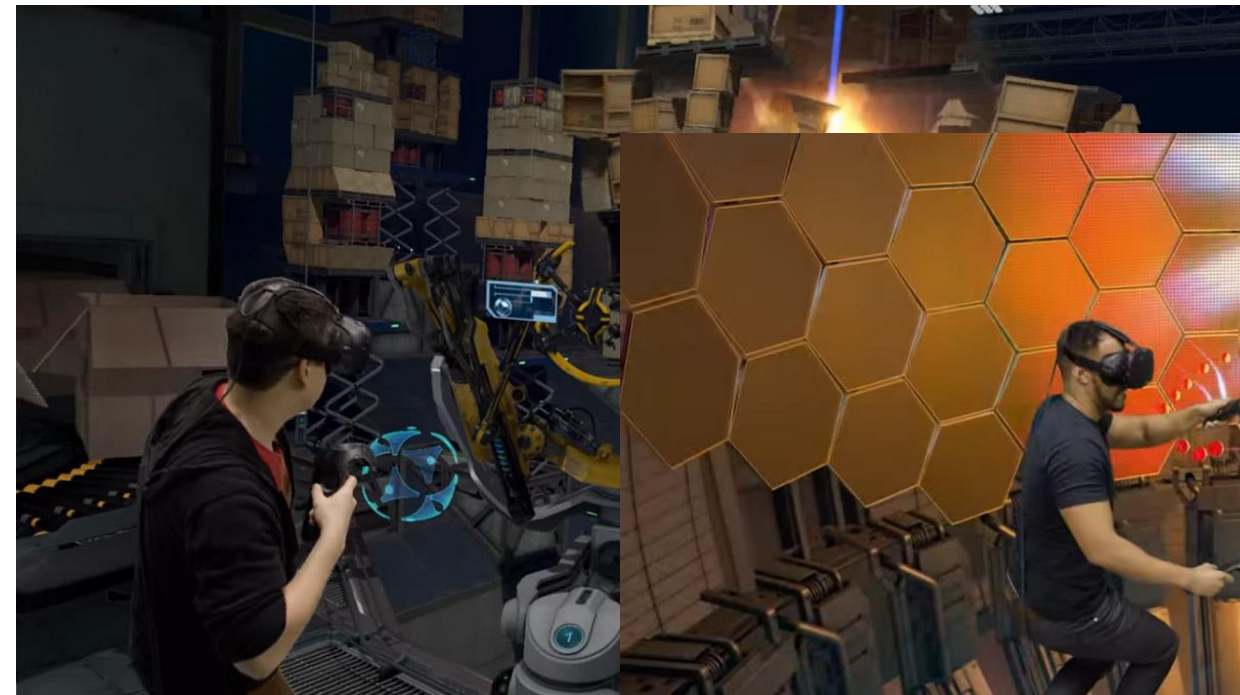
VR Evolution

- VR separates the person from physical environment and creates an immersive world that other medias are never able to produce
- Computer generated 3D graphic is capable of simulating complicated scenarios virtually and vividly
- Immerse in the virtual environment for better learning and training experience
- VR gives people the ability to interact and manipulate objects in the simulated environment just like they are in the real world



Head-mounted display

VR Application: Entertainment



VR Medical Training

- Perform “hands on” procedures in a safe and controlled setting
- Can learn from mistake with no risk to the patient
- Acquire skills in virtual environment and then apply in the real world

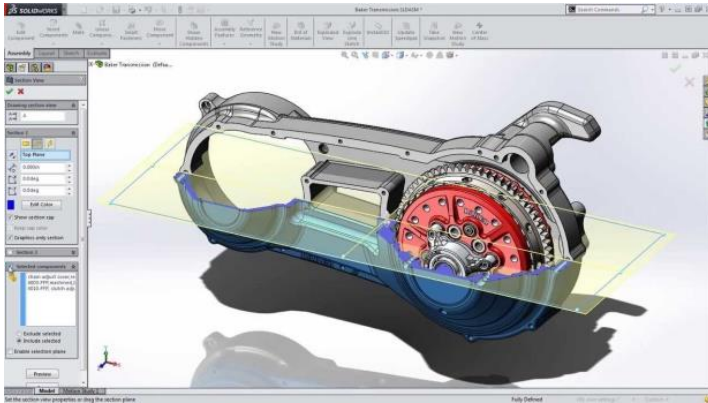


VR Manufacturing

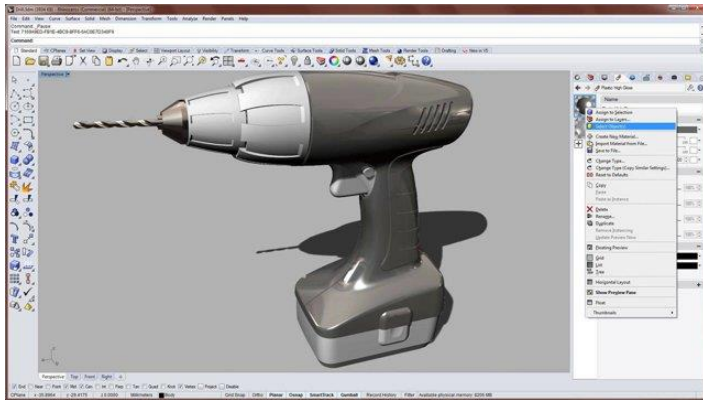
- Review design of products with virtual reality to reduce the cost of producing actual prototype
- Train workers in “what-if” scenarios in a virtual environment to reduce incidents, injuries and delays in production
- Build virtual prototypes of vehicles and equipment for evaluation, QA, and design review



VR workflow for manufacturing



Solidworks



Rhino



VR
Software



Inspect the design model from every angle at every conceivable scale easily in the VR environment that the 3D rendering on a computer screen can never offer

VR Study Case: Hospital Design Build

- McCarthy building company used VR technology to design and construct the Martin Luther King Multi-Service Ambulatory Care Centre in Los Angeles in 2013
 - Doctors and nurses wore VR headsets to provide professional advice on logistical details such as equipment placement
 - VR provided full immersion – participants could move objects in VR to the required locations



Why VR is used for the project

- Virtually practice moving patients quickly and carefully through facility
- Staff and doctors can easily assess equipment access using VR interface
- Doctor and nurse were involved with the design decisions
- Partner with individuals with expertise in hospital equipment and furniture placement
- Save time by avoiding unplanned changes
- Faster project approval
- increase positive client interaction and satisfaction



AEC VR Development Focus

- Early VR Cave Environment
- Mobile VR Headset
- Head Mounted Display
- VR software development
- Architectural VR Design Review
- Construction applications

Early VR Adoption: Cave Environment

- CAVE was first developed by an R&D team at University of Illinois in 1992
- Displays virtual content onto room-sized screens by stereoscopic projection
- User wears 3D glasses or a head mounted display inside the CAVE to see 3D graphics
- Allow multiple users to become fully immersed in the same virtual environment at the same time

Set up

- Rear projection walls
- Down projection floor
- Speakers at different angles
- Tracking sensors in the walls
- Sound/music
- Video



Pros and Cons of Cave Environment

Pros:

- CAVE gear allows participants to see each other in VR
- Room scale VR

Cons:

- Very expensive
- Cannot be used offsite due to fixed equipment setup

Phone-based VR headset

Samsung Gear VR



- VR Apps
- Work with only Samsung phones
- Built-in controller

Google Cardboard



- Inexpensive
- Works with all phones
- Need Bluetooth device for movement controller

Mobile VR Headset

Pros:

- Affordable: relatively inexpensive
- Portable: lightweight and easy to carry

Cons:

- Frame rate and resolution is phone dependent
- Lack of more sophisticated controls
- Head tracking is limited

Head-Mounted Display Headsets

Oculus Rift



- Supports more VR capability
- Supports Time-Warp
- More comfortable to wear as it is lighter
- Simpler - single IR camera detection

HTC Vive



- Let you walk in the virtual world
- Support positional tracking
- Motion controllers give you the experience of grabbing things
- Dual Lighthouse detection – larger movement area

Set up for HMD VR headset



- VR-ready computer or laptop
- Lighthouse for head tracking
- VR PC apps

Head-Mounted Display Headsets

Pros:

- PC based implementation - better performance scaling for both frame rate and resolution
- Use lighthouse IR sensor or IR camera for better head tracking and space navigation
- More intuitive and sophisticated controllers
- Room-scale navigation

Cons:

- Wired connection - cable connecting VR headset to computer limits movement and creates tripping hazard

VR AEC Software

1. Panoramic 360 video or photo VR

- Create virtual tour
- PTGui, Kolor

2. Generic game engine approach

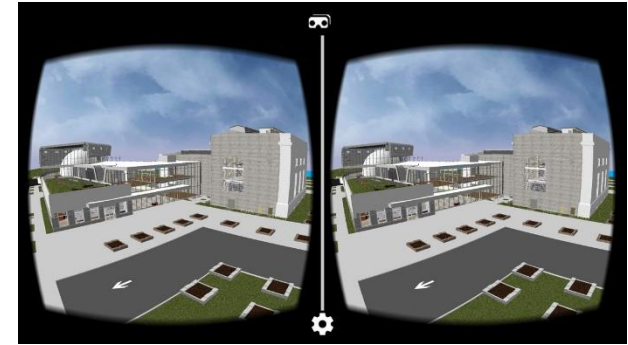
- Mostly used for very specific or custom purposes such as safety training, design review
- Unreal, Unity3D, Stingray, CryEngine

3. Turn key VR interactive simulation approach

- Mostly used for design review
- Enscape, IrisVR, Fuzor

Panoramic 360 VR

- Stitches a series of photos or videos for 360 viewing
- Combines several conventional video streams
- Major disadvantage - unable to do interactive walkthrough and simulation



Generic Game Engine for VR

Game Engines

- Well known for its nice rendering
- Knowledge of programming and scripting
- Model must be reduced to the game engine specification
- Mostly done by external contract companies

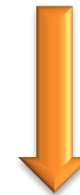
3D Authoring Software
(Revit, ArchiCAD,
Solidworks, Rhino,
Sketchup)



**Conversion and
Optimization**
Process using 3D
Studio Max or Maya



**Programming and
Scripting**



VR Application

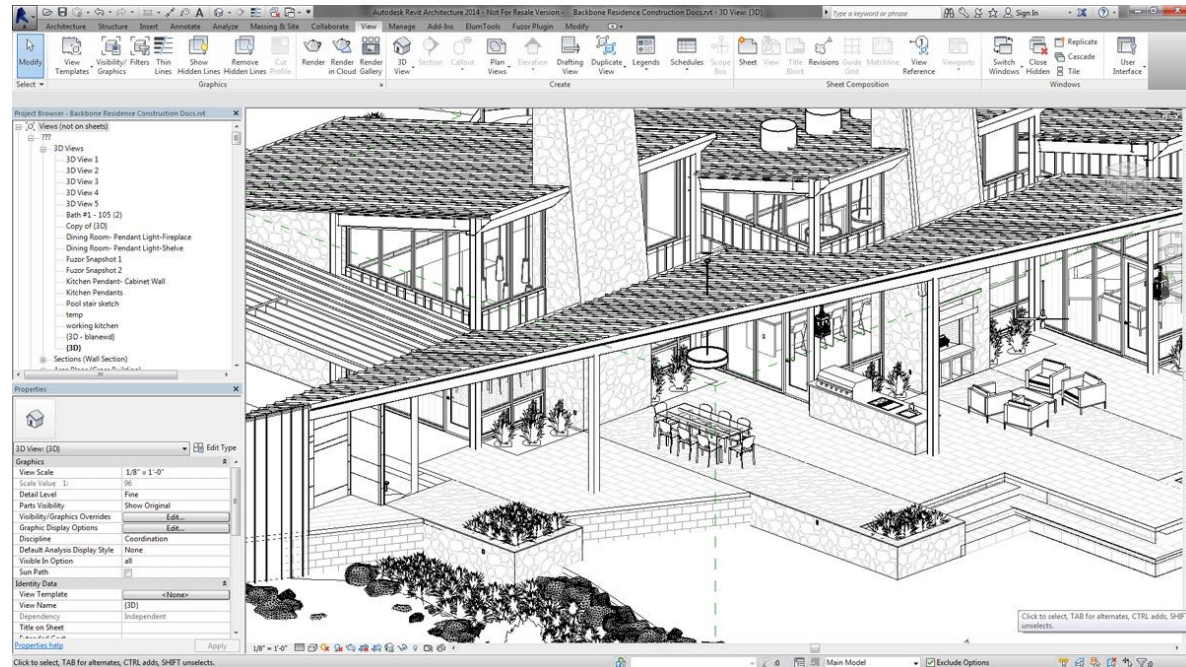
Game Engine VR Challenge

- Conversion process from design model to VR software is lengthy and complicated
 - Polygon reduction
 - texture and shade remapping
 - light baking
 - Programming and script for custom features
- design and VR visualization can be out of sync
- Mainly for visualization and lack the capability of editing and modification in the VR environment
- Not suitable for rapid design, visualization and simulation due to its turnaround time

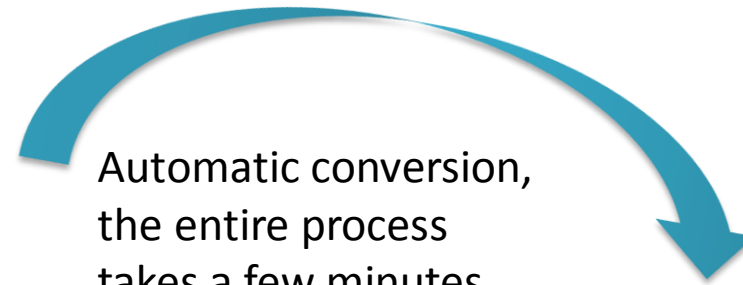
Turn Key VR Approach

- Automatic conversion from design model to VR software within minutes
- Optimization process is not required
- Support real-time modification and can be live-linked with model authoring software
- Speed up design process and increase productivity
- Can be easily done by internal staff instead of hiring external contractors

Turn key VR interactive walkthrough



**Building Drawing Software
(Revit, Solidworks, ArchiCAD, Sketchup, Rhino)**



Automatic conversion,
the entire process
takes a few minutes

Interactive VR Software (Fuzor)



Advantage of Interactive VR simulation

- Help both clients and in-house teams better visualize their projects
- Head-mounted displays (HMDs) allow designers to experience “full scale” designs
- Experience and validate design decisions
- Enabling the creation of multiple design options and modifications

Challenges of Interactive VR simulation

- Supporting engine must maintain a high frame rate (90Hz) to avoid jumpy images that can lead to VR sickness
- Poor headset tracking can cause disorientation
- Insufficient resolution can cause aliasing issues in render
- Headset wires create trip hazard

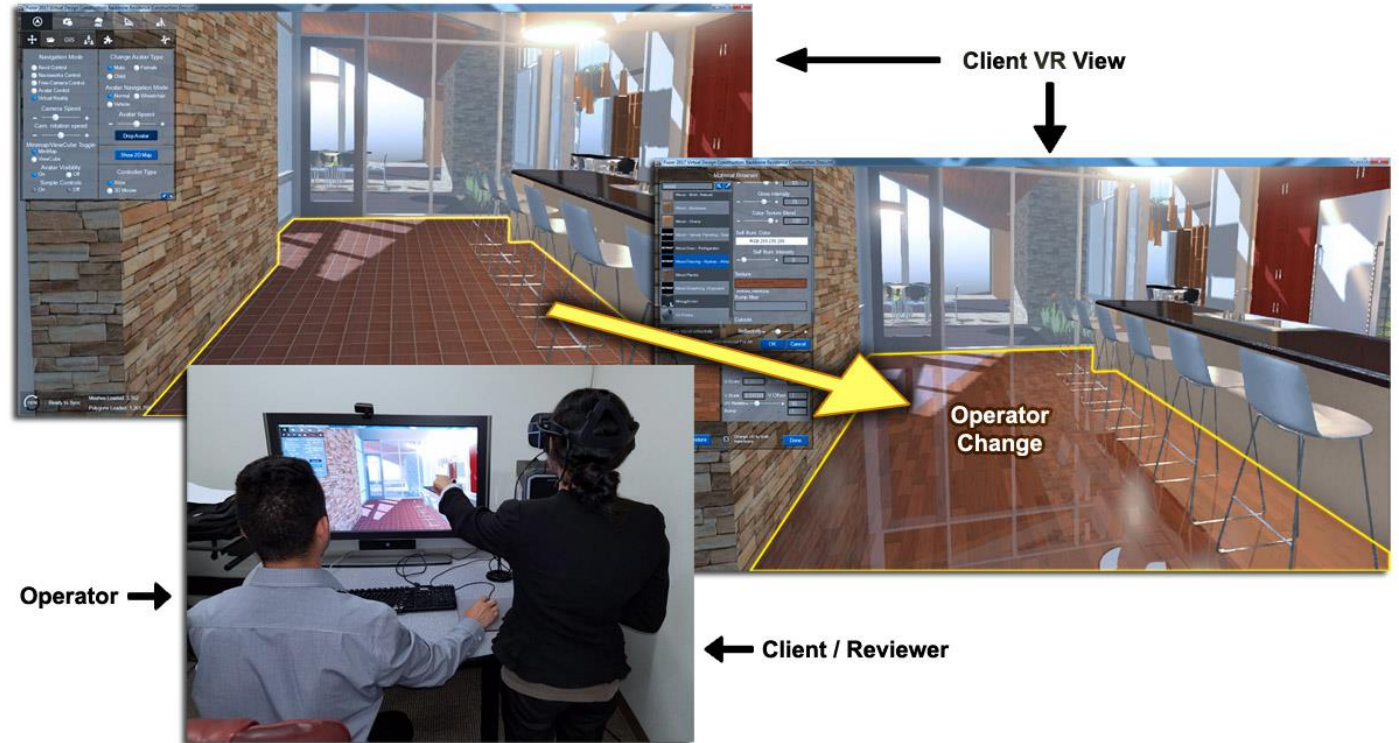
VR for Building Design Review

Walk the virtual building freely and explore spatial design



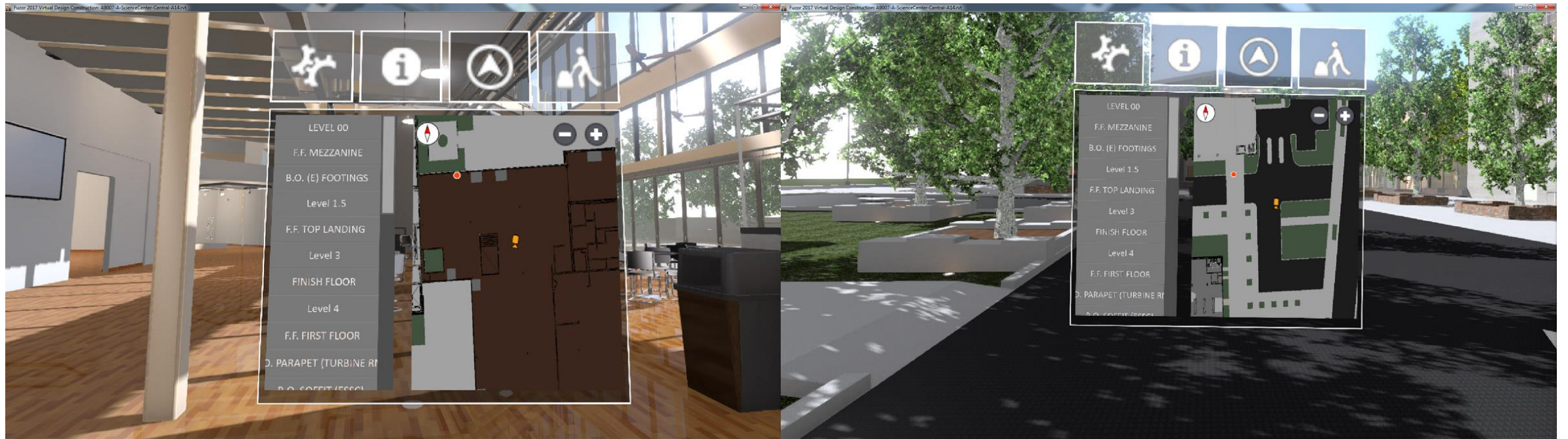
VR + Operator Mode

- Gives architects/designers the ability to respond immediately to client feedback
- Accelerates design review and speeds up the approval process
- Extended VR capacity - author-level changes can be viewed immediately without leaving VR



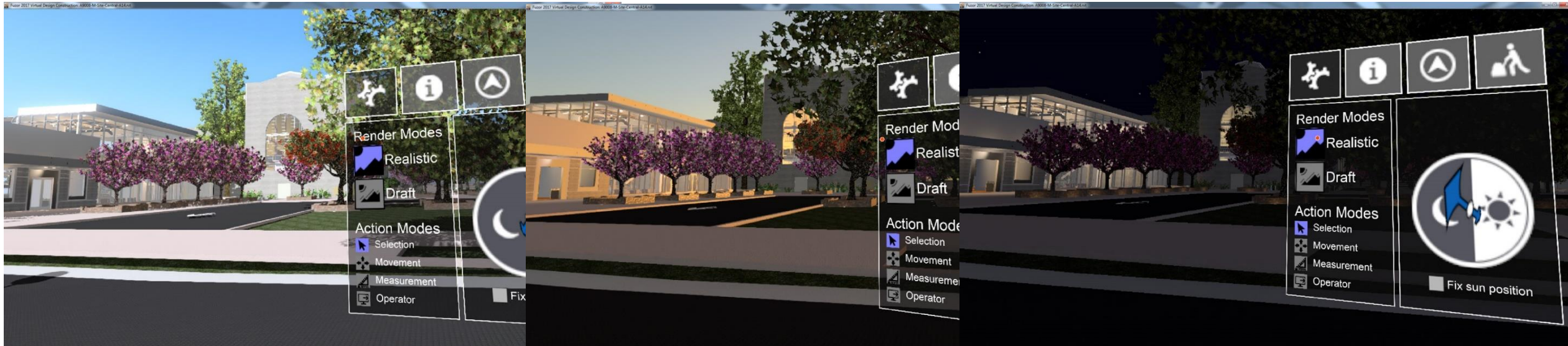
Navigation Map

- Navigation map helps users better understand their current location
- Quick movement - jump to different floors or rooms with a simple click



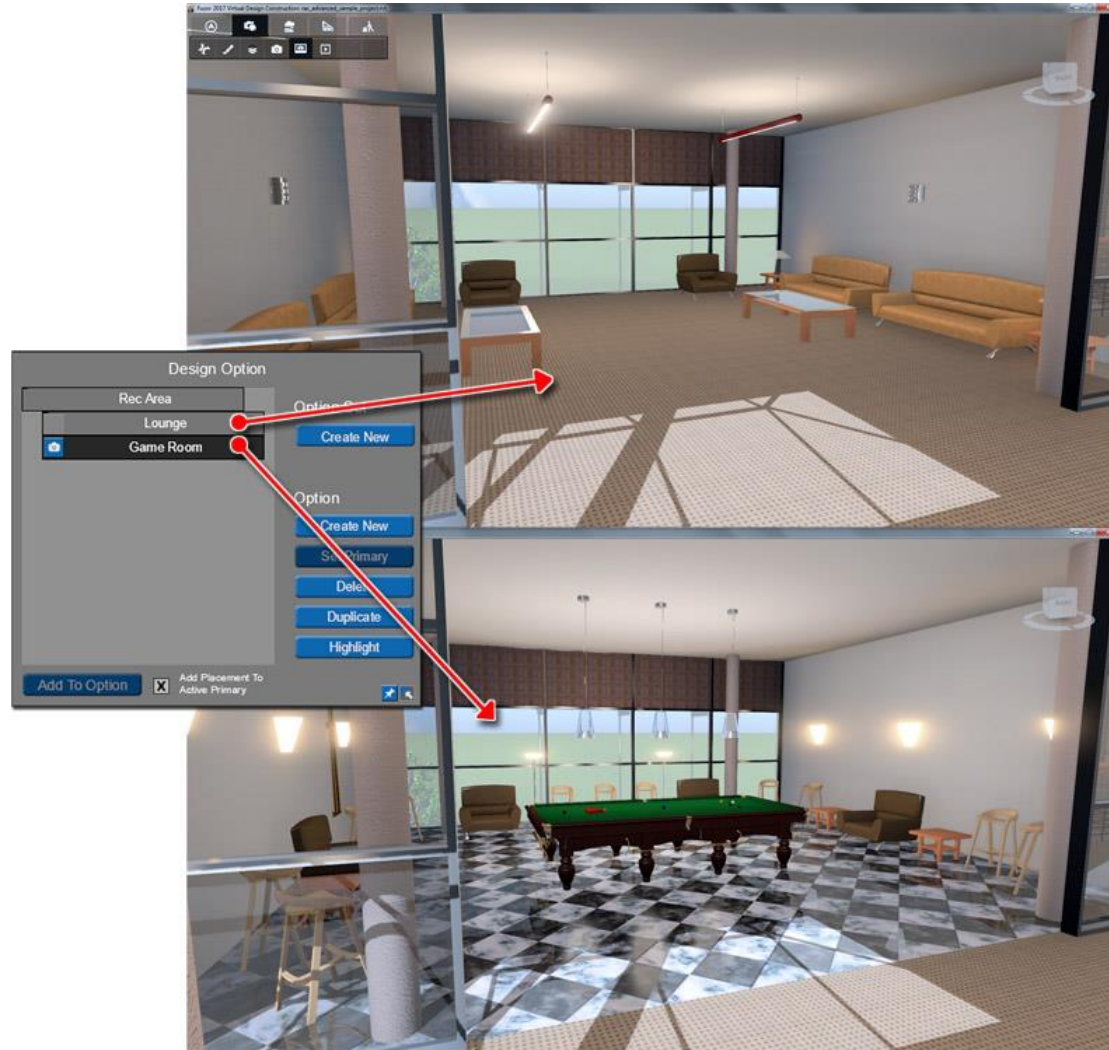
VR for Day and Night simulation

- Examine how building is affected by sun & shadow
- Review lighting design



VR for Design Options

- **Endless Possibilities -**
Create “what if” cases for material changes, object placement, lighting, and more
- Show different design options easily



VR for Instant Modification

- Instant modification based on client's feedback
- Design change can be synced back to authoring tool such Revit, ArchiCAD



Import Project

Make Changes

Sync Changes Back

Fuzor VR Design Live Demo

Why VR is used for Construction

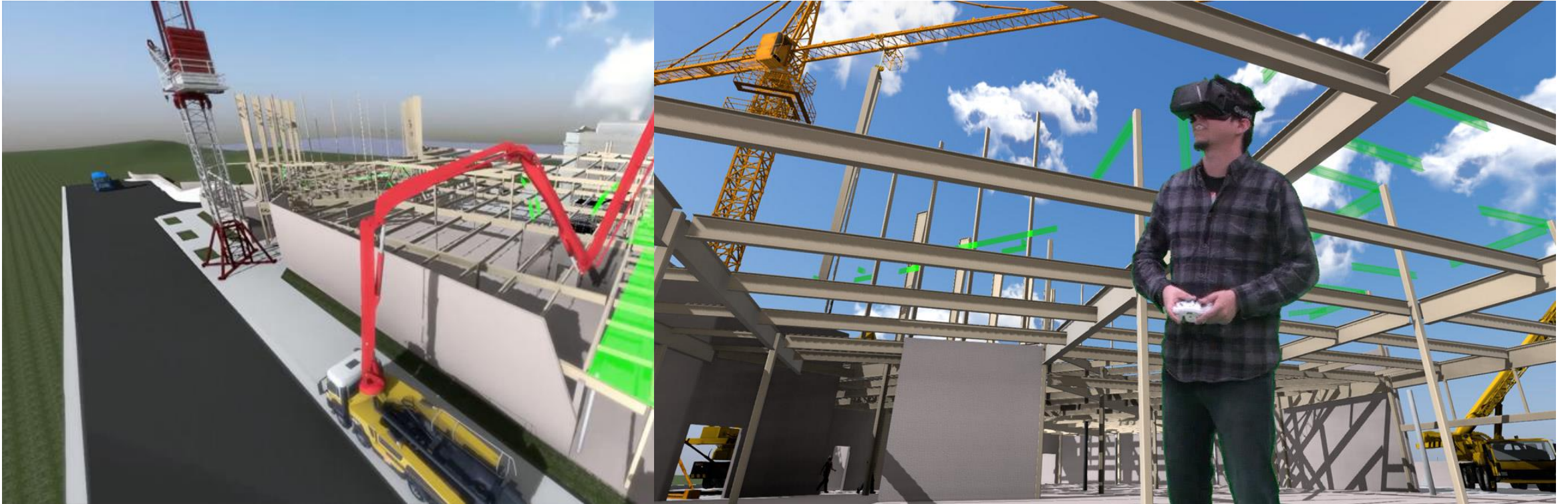
- Visualize site logistics – Construction teams can resolve virtual logistics problems before they become actual delays
- Preemptively resolve design conflicts - Extremely expensive and time-consuming to make changes once construction process is underway
- Spatial Sense - Drawings and renderings cannot convey the spatial nature of buildings or site activity
- Client Satisfaction – Client feels immersed and informed on their investment

Why VR is used for Construction

- Save time and money - Costly to create physical mock-ups of an actual building environment
- Collaboration between disciplines - Clashes can easily be detected and corrected before independent system installation begins
- Increased Confidence – Gives a visceral feeling that project can be constructed as designed
- Value-added service – Additional capability at potentially little to no net cost

VR for Construction

- First-person walkthrough the virtual construction site
- Help understand & identify potential hazards before going to the real construction site



VR for construction

- Visualize the construction sequence, jobsite activities



- Help construction manager to monitor the construction progress and test different building processes
- Give planner a better perception of the complexity of project and allocate resource better



Interactive VR solution

- 4D Construction sequence for simulation actual building timeline
- Adoptable to all construction sites easily which means a few minutes to convert the construction site model to VR
- Better training for workers
- Safety planning



Safety Simulation Video

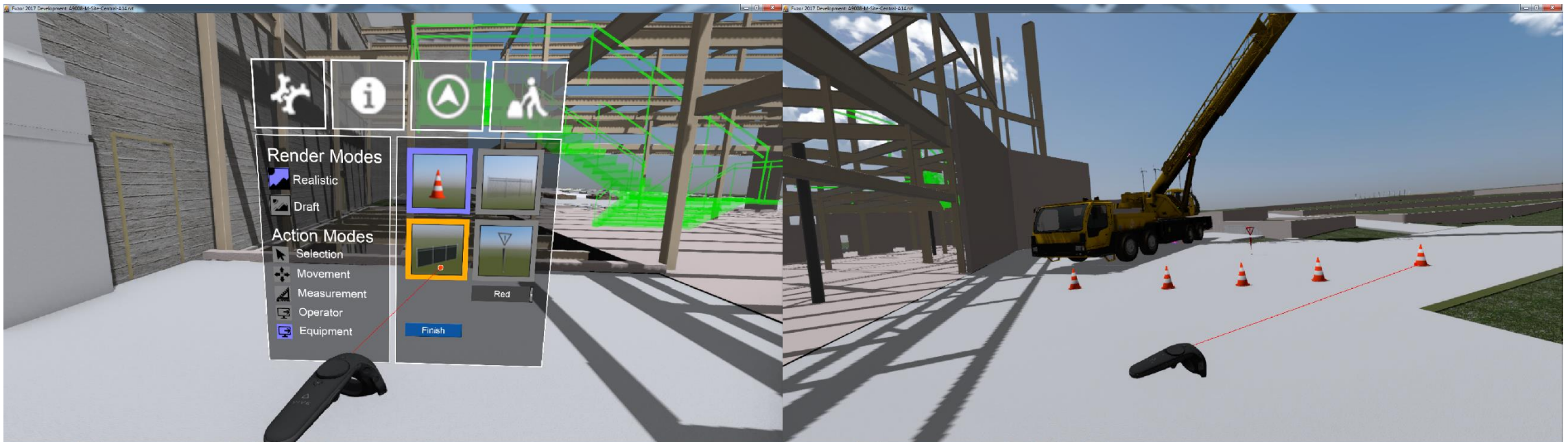


VR for Construction Safety

- Adopts VR for safety training to reduce accidents on construction sites
- Used game technology to simulate life-threatening scenarios (improper vehicle operation, falling objects, working at height)
- Construction workers wear VR headsets to walk through the site and experience the hazards vividly
- Help workers understand the consequence for improper practice and remember safety rules

VR for Safety Training

- Safety Officer can wear VR headsets and check out the construction sites
- Identify hazards and help avoid the risk when they go to the real site

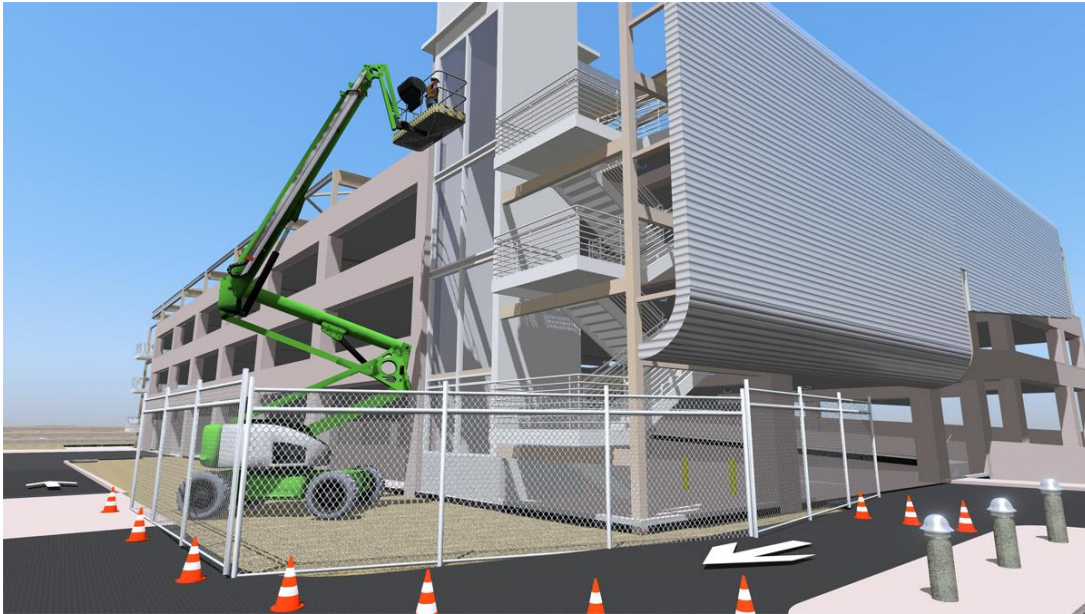


VR interface for placing equipment

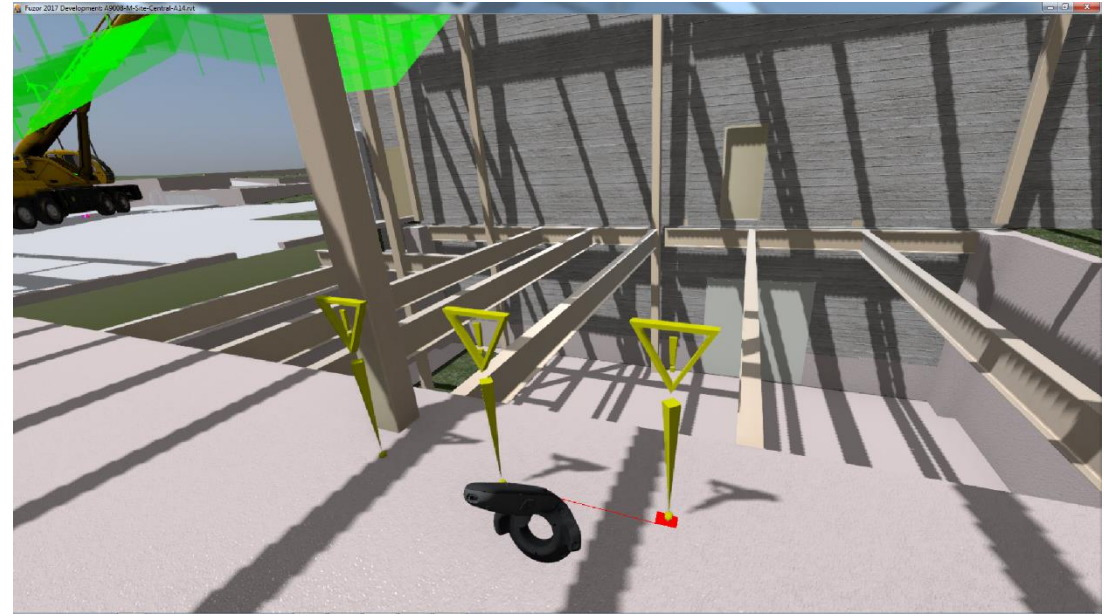
VR pointer for safety cone placement

VR for Placing Safety Equipment

- Examine how, where and when safety equipment is needed



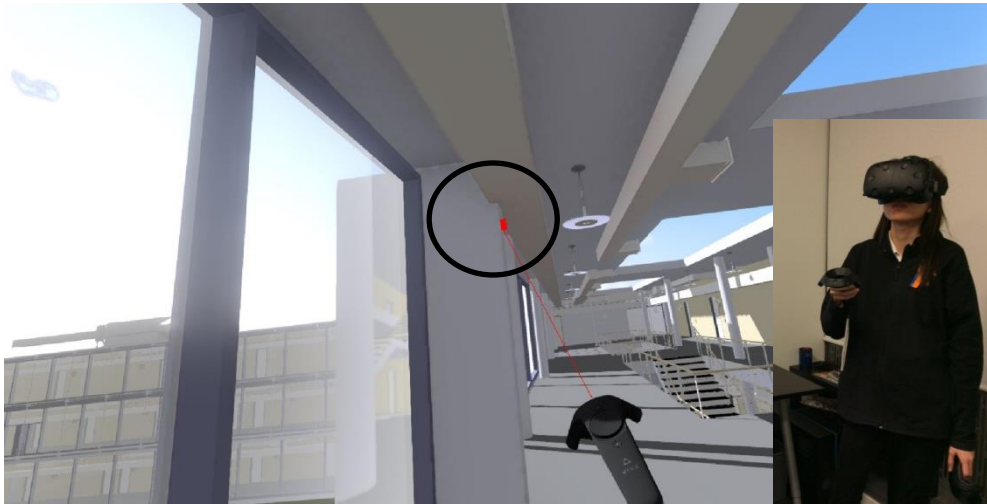
Chain link Fence & Road Cones



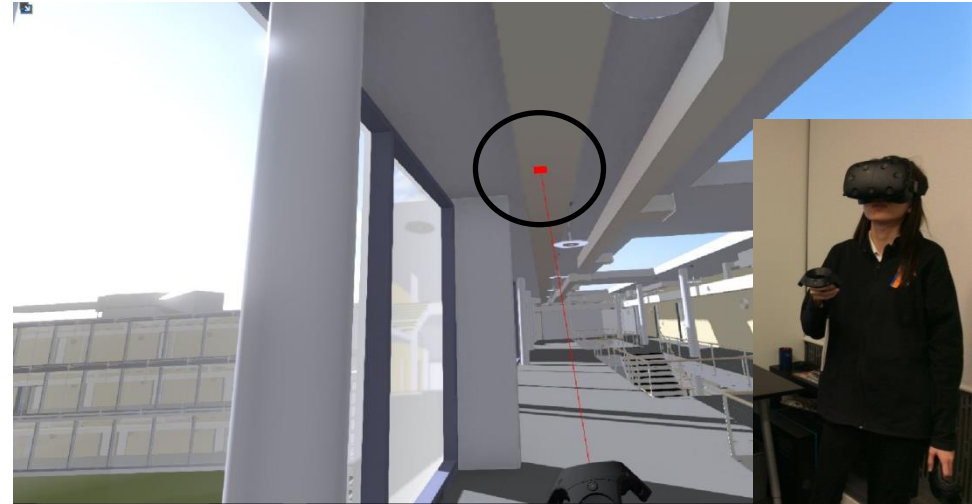
Use markers to set warnings

VR for Building Engineering

- Help examine the clashes of mechanical, electrical, Plumbing
- Make modification in VR environment



The duct clashed the wall



Move the duct to fix it

Fuzor VR Construction Live Demo

VR future and beyond

VR Collaboration

- Real-time interaction and live information exchange

Augmented Reality and Mixed Reality

- Place and view your model in a real-world context
- Enable the real world affect and interact with your placed model

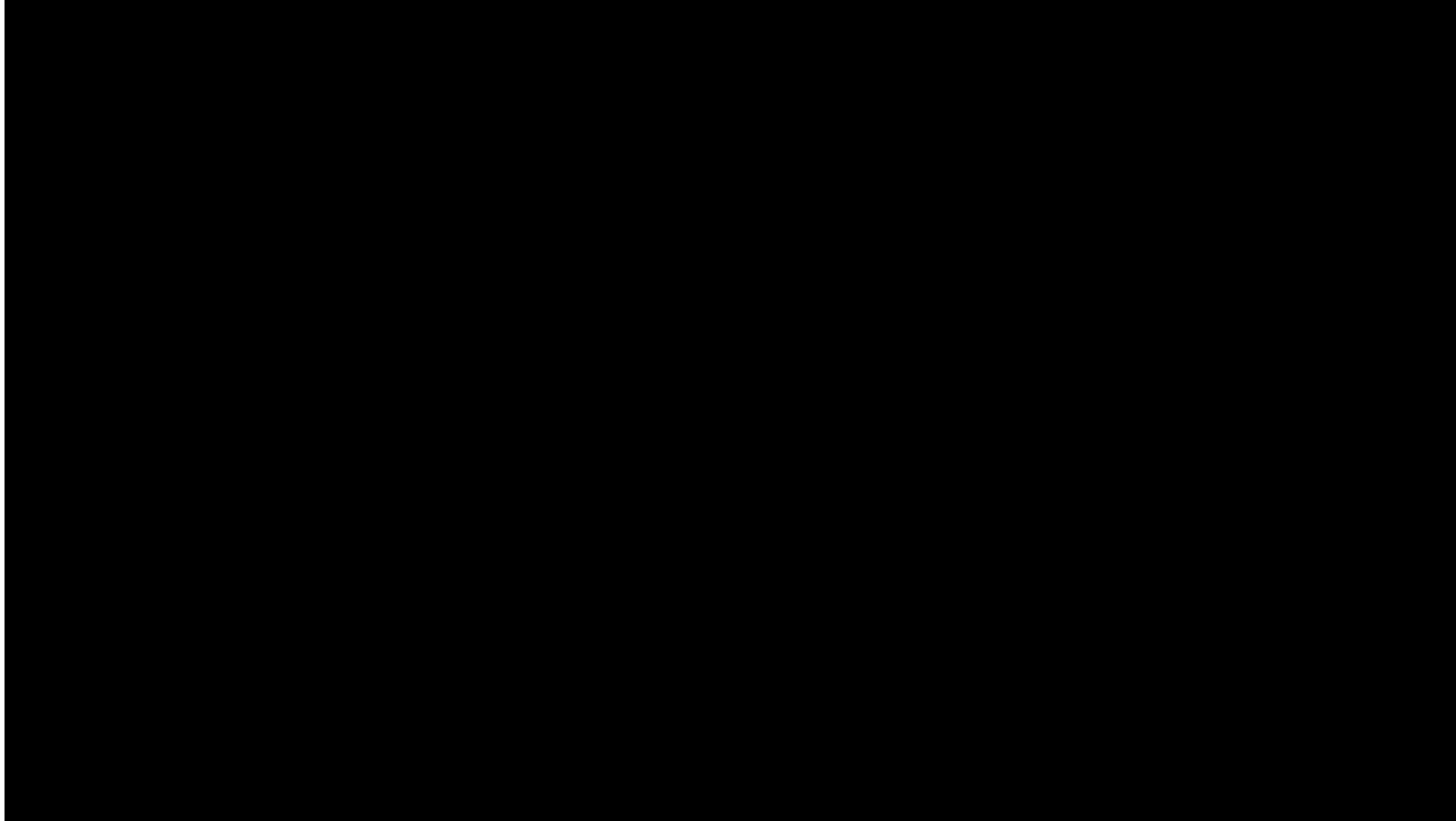
Evolution of VR in Electronics

VR Collaboration



- Different disciplines/users from different locations can collaborate & interact in the same simulated virtual environment
- Design can be presented, explained and changed in a shared virtual building
- Instant feedback from other parties
- Avoid misunderstanding & errors

Interactive VR Design video



<https://www.youtube.com/watch?v=j1vpAoC6rOA>

Augmented Reality

Augmented Reality - Using Microsoft HoloLens

- Superimpose 3D holographic content onto physical world
- Give holograms real-world context and scale
- Interact with both digital content and real world



Mix Reality

- Bidirectional AR - Let's the real world and the model interact with each other
- Examine project under real-world conditions
- Visualize interactions and collisions between virtual model and existing environment
- Rapidly prototype virtual solutions under actual circumstances



Evolution of VR in Electronics

Increase in demand for VR Tech devices

- Additional headset brands (apple VR, google glass, Microsoft HoloLens, Razer OSVR)
- 360-Degree Video Cameras (GoPro, Lytro and more)
- Motion recognition devices - gloves, handsets such as Oculus Touch, and LeapMotion
- 3D-Audio systems
- VR potential for next-gen gaming consoles



Summary

- VR gives a much better sense of depth
- More engaging interaction with colleagues and clients
- Allows for more realistic simulation of actual design use
- Reduce cost in producing actual prototypes or mock up flats
- Help eliminate options or methods that are not feasible
- Prevent potential construction hazards
- New VR Software facilitates VR implementation by significantly lowering down the conversion time and production cost
- Enable the development of more VR applications across architecture, engineering, construction with extended capabilities and new workflow in VR environment

Thank You!

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www.kalloctech.com

Reference

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