Using Immersive Technologies to Enhance Safety Training Outcomes

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Introduction and Agenda
Why are we here?

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- Project Manager, Business Technology Solutions
- Implementation consultant for EHSSQ management information systems
- Support technology implementation across AECOM’s business lines and geographies
Using Immersive Technologies to Enhance Safety Training Outcomes

Agenda
- Immersive Technology – What Terminology is Useful to Know?
- Immersive Hardware – What do I need?
- Immersive Medium – What does it look like?
- Why immersive safety + training?
- Case Study
- Open Discussion

Immersive Technology
What terminology is useful to know?

<table>
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<tr>
<th>Immersive Technology</th>
<th>Virtual Reality</th>
<th>Augmented Reality</th>
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Immersive Technology
Technology that blurs the line between the digital and physical worlds
VR = Virtual Reality

Creating a world of complete immersion

Involves hardware that blocks out, to varying degrees, the physical world and places the user in one that is completely fabricated.

AR = Augmented Reality

Overlaying 3D models and other graphics onto live, physical-world images

Typically using the camera on your phone or tablet to establish an image of the physical world around you, then placing the selected digital images "onto" that image of the physical world.

MR = Mixed Reality

A Subset of AR

The merging of real and virtual worlds where physical and digital objects can co-exist and be interacted with in real time.
Immersive Hardware
What do I need?

Disclaimer: I am not attempting to represent the entire industry or endorse particular vendors or solutions

- HTC Vive
- Samsung GearVR
- Google Cardboard
- Mobile/Tablet/HMD
- Microsoft Hololens

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In Summary

VR Ready computer required for Vive or Oculus
PC or Laptop
Consumer minimum specs:
1. Intel Core i5-6300HQ processor
2. Nvidia GeForce GTX 980, 1060, 1070 or 1080 GPU
3. 8GB of RAM
4. Two USB 3.0 ports
5. HDMI 1.4
6. 1920 x 1080 display
7. Windows 8 or 10

VR Compatible Computer

- VR-Ready computer required for Vive or Oculus
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360 Degree Cameras

- Ricoh Theta S
- Gear 360
- LG 360
- GoPro Fusion
- GoPro Omni

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Immersive Medium
What does it look like?

- Shot with 360 camera
  - Still or film (panoramas or movies)
  - Easy to overlay content
  - Wide range of visual quality
  - Limited interactivity, does not allow for free range movement

Live Imagery

- What you can imagine can be created
- Move anywhere
- High interactivity
- Wide range of visual quality

Computer Graphic Imagery

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VR CAVE

Immersion Technology
Why Safety + Training?

Learning Pyramid
Natural Training Strategies

- Lecture: 3%
- Reading: 10%
- Audio-Visual: 39%
- Demonstration: 39%
- Discussion Group: 39%
- Practice by Doing or Writing: 75%
- Teach Others/Immediate Use: 98%

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Why Simulation?

- Time spent in structured, measurable simulation training is significantly more valuable than time spent by any other learning method.
- Simulator training achieves 78% retention, while the average of all other methods is 11.6% when blended equally.
- This means that simulator training is nearly seven times more effective than any other learning method, not including on-the-job training. In many cases, even OJT is unstructured and not measurable.

Why Simulation?

- “Research sponsored by the American Red Cross shows that simulation learning in combination with traditional classroom experience is more efficient and effective in preparing people to act in a crisis than traditional classroom learning or online learning alone.”
  - Practice skills, make decisions and commit errors without real-world consequences.
  - Introduce real-world variables that offer greater challenges and training dimensions.
  - Improve retention by allowing trainees to repeatedly test their skills and knowledge at their own pace and in a variety of scenarios and roles.
  - More engaging and effective than classroom learning alone.

Benefits of Incorporating VR into your Training Program

- Reduces speed to commissioning/competency
- Maximizes the value of time spent in training
- Replaces wasted time spent in largely ineffective and often unenjoyable training by employees just to complete their required qualifications.
-Eliminates the need for constructing purpose-built training facilities and associated travel
- Allows for “exposing” workers to hazardous situations and to accidents without putting them in danger
- Always available and can be set up for trainee self-study
- Alleviates some of the training responsibility that often falls on senior personnel, whose time is already stretched thin
- Can be easily expanded and updated year after year

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High consequence learning is targeted at high-consequence, difficult and important items. O&M tasks with high-consequence JHAs should be considered for simulation training as well as those that affect KPIs. The hazardous nature of many job and construction sites in and of itself makes onsite training difficult and prevents training through experience of failure.

Past problems:
- Identify any past problems or incidents that should be included in training
- Learn from inquiry-based methods and immediate feedback

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Case Study

Construction safety training using immersive virtual reality

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Hypotheses

- The first hypothesis was that trainees would perceive the virtual construction site environment to be a sufficiently authentic simulation of a construction site to facilitate learning.
- The second hypothesis was that safety training in the virtual construction site would be more effective, in terms of workers’ attention, learning and recall, and their ultimate success in identifying and assessing construction safety risks, than would training using conventional methods.
- An additional specific goal was to gain practical knowledge about the virtual construction site and its use: to learn from the implementation and from the conduct of the training sessions.

Methods

- Three groups with a total of 66 subjects were tested.
  - Groups 1 and 3 were comprised of construction workers from a cast-in-situ concrete fabrication training course - limited work experience, but familiar with construction site environments.
  - Group 2 was composed of third year BSc civil engineering students - limited work experience and little or no prior experience of the construction site environment.
- Knowledge tested prior to the training, immediately following and one month after:
  - ½ received traditional training (classroom with visual aids), ½ received 3D immersive VR “power-wall” training
  - Power-wall setup consisted of three rear-projection screens, each 2.4m wide and 1.8m high, arranged in a ‘theatre’ with a 150° angle
  - Head tracking system and XBOX controller
Results

- Test before and immediately after training:
  - Results varied depending on the sub-topics of the safety training
  - Those who had the traditional training rated the risk levels higher after the training. The VR training groups reduced their risk level assessments after training.
  - VR was significantly better than traditional training for hazard identification for reinforced concrete works and for stone cladding works and for learning prevention knowledge for the cast-in-situ concrete works.
  - Although the results indicate an advantage for the general site safety topic as well, this could not be asserted with confidence.

- Test before and 30 days after training:
  - Only for the topic of cast-in-situ concrete works did VR training prove to be statistically significant on identification task and on the prevention task.
  - Due in part because of small sample size

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Conclusions

- Conclusions:
  - Significant advantage was found for VR training for stone cladding work and for cast-in-situ concrete work, but not for general site safety.
  - VR training was more effective in terms of maintaining trainees’ attention and concentration.
  - Training with VR was more effective over time, especially in the context of cast-in-situ concrete works.
  - Given the need for improved training and the advantages of training using VR, incorporation of VR in construction safety training is strongly recommended.
Open Discussion

Demos

- HTC Vive
  - Gas Plant Operator Simulation
  - Hydrostatic Testing
  - Shipyard Hazard ID

- Gear VR/Cardboard
  - Remediation Site Hazard ID
  - Various models
  - Shipyard
  - Various 360s

- Desktop/Laptop
  - Various 360 tours