TunnelSkills Immersive Learning AR

TunnelSkillsAR User Guide
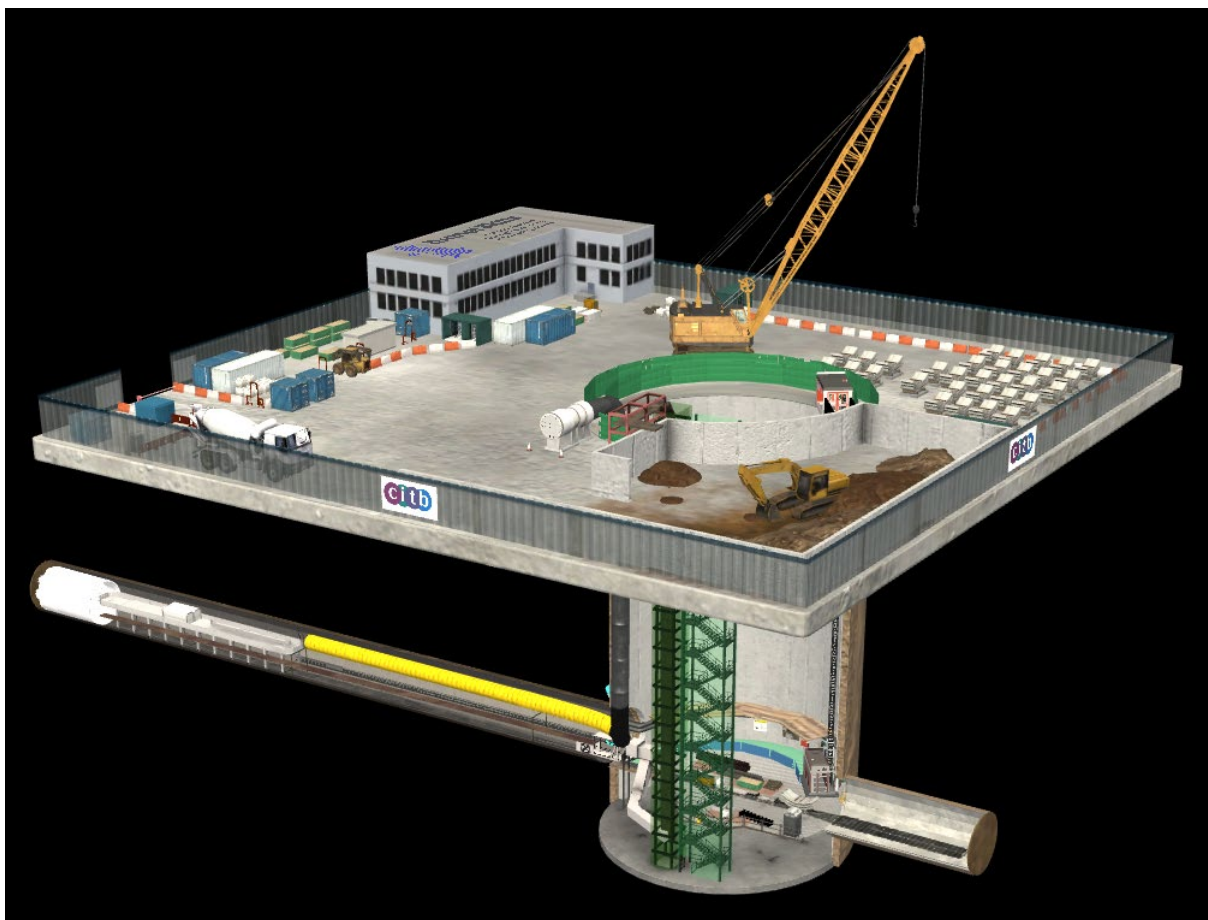
Table of Contents

1. Immersive Learning

Immersive learning encompasses augmented, virtual and mixed reality and other forms of alternate, expanded or immersive reality. It aims to provide access to experiential training which is inaccessible in traditional classroom teaching. It offers comprehensive learning experiences when used in combination with traditional methods.

The TunnelSkills Immersive Learning Project funded by CITB uses a mix of AR and VR technologies with AR learning applications and VR content and scenarios in different formats. These can be used in a range of training environments to build awareness. They will also be used to show and promote the tunnelling environment and associated activities at industry events and in educational settings in schools and colleges.

Figure 1: TunnelSkills Immersive learning application showing the tunnelling site

The AR learning application will give learners and users an awareness of tunnelling and its environment, placing emphasis on safety and understanding the hazards of working on construction activities underground. The scenarios in the application step users through the process in a highly visual and engaging way, so users can be prepared for entering a shaft and tunnel for the first time.

Training in an immersive environment ensures that safety is of paramount importance and allows trainees to be placed in a hazardous (augmented) scenario. Training can be repeated, where required, until trainees are fully prepared and safe to enter the environment in the real world.

Augmented reality (AR) layers virtual content, such as digital objects or information, onto a real-world image. As AR interacts with physical environments, factors such as lighting and surface detection integrates virtual and real reality. The overlaid 3D information is a seamless immersive integration into the real environment. It allows users to view a perception of the real work where they couldn't normally have access to due to safety, costs, time and access restrictions. It allows for group-based learning and communication where it fosters interest and increases engagement. It enables free movement around environments and objects where it wouldn't be possible in real life. It can be used to complement physical training activities.

The Microsoft HoloLens is a pair of mixed reality smart glasses manufactured by Microsoft. It is a head mounted display that allows the user to place a hologram in the real world where the user can view and interact with the hologram via the device. The TunnelSkills AR application has been developed for the HoloLens and is accessed by launching it by selecting the TunnelSkills AR icon in the Start Menu.

2. Using the Microsoft HoloLens

Using a HoloLens is based on using your hands to perform gestures which allows you to interact with buttons, menus and objects. To learn the basics, open the 'Learn Gestures' application from the start menu on the HoloLens 1. Use the 'Tips' application on the HoloLens 2 to learn the basics.

HoloLens 1:
Select holograms with gaze and air tap
HoloLens 1 enables you to use your gaze to target an item and then requires you to perform and 'air tap' gesture to select it.

1. The gaze cursor is a dot that you move around by moving your head.
2. Gaze at the button\object you want to select and ensure the gaze cursor is over the hologram.
3. Point your index finger straight up toward the ceiling.
4. Air tap: lower your finger, then quickly raise it.

Figure 2: Air Tap gesture

Start gesture
To open the Start menu on HoloLens 1, use the 'Bloom' gesture; hold out your hand with your palm up and fingertips together, then open your hand by spreading your fingers.

HoloLens 2:
Select holograms with hand ray and air tap

1. Use a hand ray from your palm to target the item; a hand ray will shoot out from the centre of your palm. You don't need to raise your entire arm; you can keep your elbow low and comfortable.
2. Point your index finger straight up toward the ceiling.
3. To perform the air tap gesture, pinch your thumb and index finger together and then quickly release them.
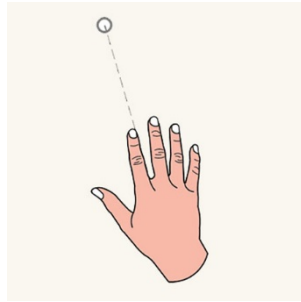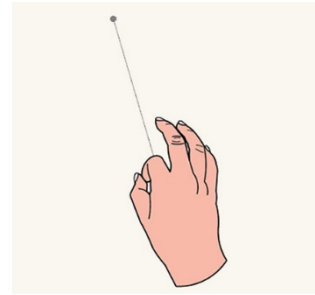
Figure 3: Hand ray + Air Tap gesture

Pointing state

In the *pointing* state, the ray is a dash line and the cursor is a donut shape.

Commit state

In the *commit* state, the ray turns into a solid line and the cursor shrinks to a dot.

Start gesture

In HoloLens 2, the Bloom gesture has been replaced with a virtual wrist button that intuitively allows you to reach out and press it with your other hand. To open the Start menu on HoloLens 2, hold out your hand with your palm up to show the wrist button, then press the wrist button with your finger.

The Gestures frame

Microsoft HoloLens has sensors that can see a few feet to either side of you. When you use gestures, you need to keep them inside that frame, or HoloLens won't see them. As you move around, the frame moves with you. When your hand is inside the frame, the cursor looks like a ring. When HoloLens can't see your hand, the cursor changes to a dot.

Calibration

HoloLens 1 and HoloLens 2 both work better when they are calibrated to your unique eyes. HoloLens 2 prompts a user to calibrate the device when using the device for the first time. For HoloLens 1, you can manually run the Calibration app at any time. You can access the Calibration app by using either the Start menu or the Settings app.

3. TunnelSkillsAR User Guide

This guide will help you understand the various features of the user interface which will help you navigate through each scenario. When you first run the application on a HoloLens from the Start menu, you will be prompted to choose a location where you want the hologram to appear. Once chosen, the application will finish loading, and the hologram of the site will appear with the three Main Menu buttons described below.

Main Menu Buttons	
	Tutorial The Tutorial button will take you to a how to use guide so that you can become familiar with the application and controls.
	Adjust Hologram (Not applicable to Web PC version) The Adjust Hologram button will allow you to move, rotate or scale the hologram so that you can position it based on the location you are aiming to use it.
	Start Application Choose this option to start the application; the Introduction Screen will appear, and the Introduction Screen commentary will play. You will see three Introduction Screen buttons. These are described below.

Introduction Screen Buttons	
	Tutorial The Tutorial button will take you to a how to use guide so that you can become familiar with the application and controls.
	Adjust Hologram (Not applicable to Web PC version) The Adjust Hologram button will allow you to move, rotate or scale the hologram so that you can position it based on the location you are aiming to use it.
	Scenario Select When you choose the home button, you will be prompted with two scenario buttons. You can either select Scenario 1 which will explain all you need to know about how to safely access the site and tunnel, or Scenario 2 which covers what to do in an emergency.

Once you have started a scenario, you will be prompted with five scenario buttons. Each of these is described below:

Scenario Buttons	
	Replay The Replay button will replay the current scene you are in which will replay the voiceover so you can listen to it again.
	Exit The Exit button will prompt you if you wish to exit the scenario and return to the Introduction Screen. Select Yes or No to confirm if you wish to exit.
	Adjust Hologram (Not applicable to Web PC version) The Adjust Hologram button will allow you to move, rotate or scale the hologram so that you can position it based on the location you are aiming to use it.
	Scenes The Scenes button allows you to navigate to a different scene in each scenario.
	Scene Select Once you have selected the Scenes button you will be shown a series of numbered buttons. Choose any of the numbered buttons to navigate you directly to that scene.
	Next Step The Next Step button will navigate you to the next scene in each scenario. You should aim to work your way through all the scenes by selecting the next step button until you reach the end of the scenario. Completing the Next Step button in the final scenes of both scenarios will return you to the Introduction Screen.

When you run the Web PC version, after the app loads, first read the brief 'How to Use' guide and then click the screen to continue. For a better viewing experience, use the full screen control (shown right) to watch the Web PC version in full screen mode. Press Esc at any time to exit full screen mode.

	Pause / Play (Web PC Version only; visible towards the bottom of the app screen) Toggle between pause and play to stop and start the action and commentary in each scene. When you press play, the action and commentary will restart from the point that it was paused in the scene.

The two scenarios are described below:

Scenario 1: Accessing the shafts and tunnels

Figure 4: Sample view of the tunnelling site

Scenario 1: Accessing the shafts and tunnels
What is this?
This experience shows you the correct procedures to follow when entering a tunnel under construction. It helps you to identify the correct PPE to wear and it provides information on site access and tunnel access points. It will also give you an overview of typical self-rescue equipment, tally protocols for entering and exiting the shaft and tunnel and how to safely use the passenger hoist when entering the pit bottom.
What will I learn?
In this experience you'll learn the following: - Safely enter the site and pit top area including the site access points   - Use the correct equipment including the correct PPE   - Understand the importance of (and consequences of not) using the personnel tally systems (in and out)   - Use of a passenger hoist to descend into the shaft

How long will the experience last?
20-25mins (approx.)

Should I stand or sit for the experience?
This is a **standing** experience. If you can, try to find a 3m x 3m space in which to place the hologram and ensure you are stood 2m away from it and the area is free from obstacles.

The augmented reality scenes that the learner will experience in Scenario 1 are:

1. Scenario 1 Introduction
2. PPE
    2.1. PPE Body
    2.2. PPE Head
    2.3. PPE Hands
    2.4. PPE Feet
    2.5. PPE Ears
    2.6. PPE Ears 2
    2.7. PPE Eyes
    2.8. PPE Lungs
    2.9. 'Start of Shift' Safety Briefing
    2.10. Observation Cards
3. Site Access
4. Security Gate
5. Walking through Working Areas on Site
6. Tunnel Access Point
    6.1. Tally Control
    6.2. Self-rescue Equipment
    6.3. Self-rescue MSA SavOx
    6.4. Self-rescue Dräger Oxy 3000/6000
7. Tunnel Access & Egress
8. Passenger Hoist
9. In the Passenger Hoist
10. Entering the Pit Bottom
    Scenario 1 Complete
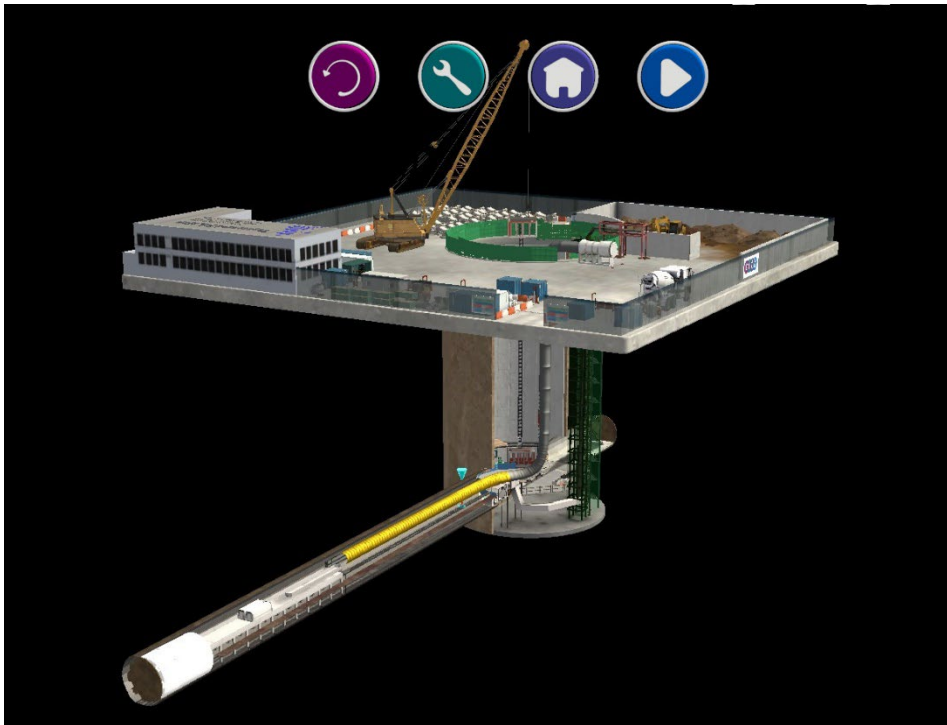
Scenario 2: What to do in an emergency

Figure 5: Augmented Reality scene from Scenario 2

Scenario 2: What to do in an emergency
What is this?
This experience shows you the correct procedures to follow when an emergency situation occurs in the tunnel. It also helps you to identify the equipment in use, equipment to use and how to make the right decision about raising the alarm, safely exiting the tunnel or escaping to a place of refuge.
What will I learn?
In this experience you'll learn the following: • Raising the alarm; reacting to an alarm • Use of self-rescue equipment • Self-rescue or escape to refuge chamber • Gas detection and gas alarms • Fire in the tunnel – raising the alarm • Fire prevention and fire suppression
How long will the experience last?
15-20mins (approx.)
Should I stand or sit for the experience?
This is a **standing** experience. If you can, try to find a 3m x 3m space in which to place the hologram and ensure you are stood 2m away from it and the area is free from obstacles.

The augmented reality scenes that the learner will experience in Scenario 2 are:

1. Scenario 2 Introduction
2. Atmospheric Monitoring
   2.1. Atmospheric Monitoring 2
3. Tunnel Emergencies - Fire in the tunnel
4. Communication
5. Making the right decision – Raise the Alarm
6. Making the right decision – Evacuate the Tunnel
7. Evacuation + Emergency Escape
   7.1. Emergency Lighting
   7.2. Water Spray Curtain
8. Refuge Chamber
   Scenario 2 Completed

4. Use in a Learning Environment

When using the AR application in a learning environment, there are some things that you need to consider:

- Choose a space that gives you enough room to place and walk around your hologram. You can scale the hologram if required at the start of the application or in each scene.
- The user must be able to stand 2 meters away from the hologram.
- The optimised layout for teaching classes of 12 is to split the class into two groups of six - one group works in the immersive learning area, and the other works in another area.

Figure 6: TunnelSkills Immersive learning application showing the tunnel shaft

- There should be a dedicated wireless network for immersive learning equipment.
- Equipment should be stored and charged securely on racks in the space.
- Cleaning products should be stored with the equipment and used for the sanitisation of HMDs after each lesson.

5. PAULEY

PAULEY are a UK based multi award-winning team of immersive technology specialists who help deliver innovative and effective digital solutions for stakeholder engagement, maintenance/fault finding, project management, skills/training and competency management.

A pioneer in establishing the Digital Engineer of the Future, PAULEY analyse, design and develop innovative operational performance support and agile blended learning applications using a range of digital immersive technologies including Augmented Reality (AR), Virtual Reality (VR), Mixed Reality (XR), Artificial Intelligence (A.I) and Internet of Things (IoT). PAULEY prove a range of Tier 1 businesses and clients with bespoke agile learning, upskilling, train the trainer and competency management.

PAULEY are world leaders in spatial computing applications for industries who help clients to optimise operational performance, reduce risk, & increase safety and customer satisfaction through pioneering applications of immersive technology.

A pioneer in spatial computing, PAULEY analyses, designs and develops innovative operational performance support and agile blended learning applications using a range of digital immersive technologies including Augmented Reality (AR), Virtual Reality (VR), Mixed Reality, Touchscreen Technology, Artificial Intelligence (A.I.) and Machine Learning. We provide a range of Tier 1 businesses and clients with bespoke agile learning, upskilling, train the trainer and competency management solutions.