VR/AR Association White Paper

VR/AR Association Training Committee Best Practices

Authors: Jeff Meador
Contributors: David Trainor, Amir Elion, Erica Schaffel, Tatum Bisley, Ramesh Verma, Kris Kolo

Thank you Banjo Digital and Precision OS Tech for the support in making this white paper possible.

www.banjodigital.com
www.precisionostech.com

Table of Contents

This white paper is broken into the following parts so you can skip to what is of interest to you:

Forward

The VR and AR landscape is fast evolving and provides benefits across many industry verticals. One of the most widely hailed applications of VR and AR is in Training/ Learning & Development because of the seemingly boundless array of possibilities and benefits compared to traditional training methods.

This document outlines and details a set of best practices, aiming to capture the rapidly-evolving field of VR and AR and its use in training and skills development. It is intended for novices to VR and AR technologies which are knowledgeable in current training methodologies and experienced in the general training market.

While this document provides an extensive discussion of current best practices and usages, VR and AR continue to grow organically and rapidly. We encourage you to experiment and push the boundaries of what is currently possible with this technology.

The VRARA Training Committee will ensure this document is current through regular updates every six months .

1 Introduction to the VR/AR Association

The VR/AR Association is an international organization with thousands of registered companies and over 50 global chapters. Its mission is to accelerate collaboration in the rapidly developing Virtual Reality (VR) and Augmented Reality (AR) ecosystem to promote research, education, and the development of industry standards in this nascent but rapidly developing field. It is comprised of 24 committees focused on specific technologies and applications.

The Training Committee

The Training Committee is comprised of training professionals, technologists, digital media creators, business leaders, and entrepreneurs that bring tangible experience across many years and applications. The committee's mission is to foster the improvement of learning across all vertical sectors via the use of VR and AR technologies.

2 A Quick Word about Terminology

The rapid evolution of immersive technologies and innovative companies striving to carve out their mark has resulted in many terms and definitions getting confused or conflated. There is a glossary of acronyms and terms used when discussing these technologies at the end of this document. For the sake of clarity, we will refer to all immersive technologies as XR (extended reality), as the core belief is that all of these technologies provide users with an extension of their current reality. Where this document refers to a specific extended reality technology, the correct and specific terminology will be noted.

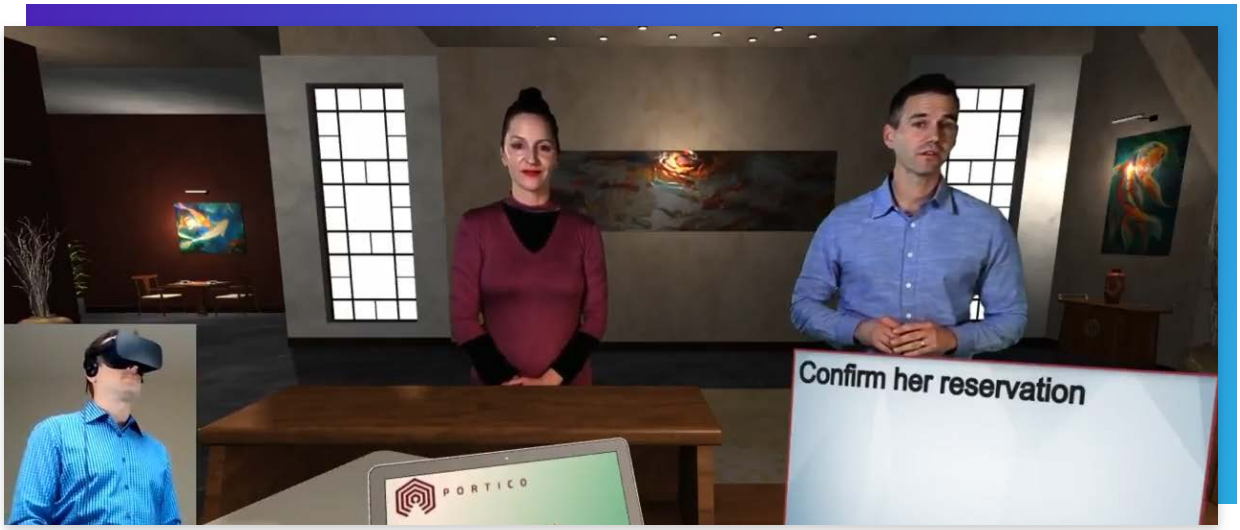


Photo courtesy of Portico
VR Hotel front desk training

3 XR Technology Types

When developing training tools using XR, it's best to determine the right type of technology to meet your specific training goals. A good fit will enable you to leverage XR technology to maximize the benefits to both the learners and the organization.

In the market today, there are four types of XR training available: 360 Video, Virtual Reality, Augmented Reality, and Mixed Reality.

360 Video

360 Video is a video format that records in all directions simultaneously. It offers users the most realistic way to view an environment in a fully immersive manner. Users have the ability to control the viewing direction but are extremely limited in other interactions with the scenario.

Some benefits from 360 video include:
- Few performance problems, even on mobile/ low-end devices
- Easily distributable to large audiences
- Full control of narrative elements

Some drawbacks of 360 video include:
- Lack of interactivity; limited to observational views only
- Updates can require an entire film crew

Common training uses of 360 video include:
- Teaching observational tasks such as surveying the safety of a construction site
- Familiarizing a learner with a new area, such as a newly designed cabin on an aircraft
- Preparing a learner for a rare event, like Black Friday sales

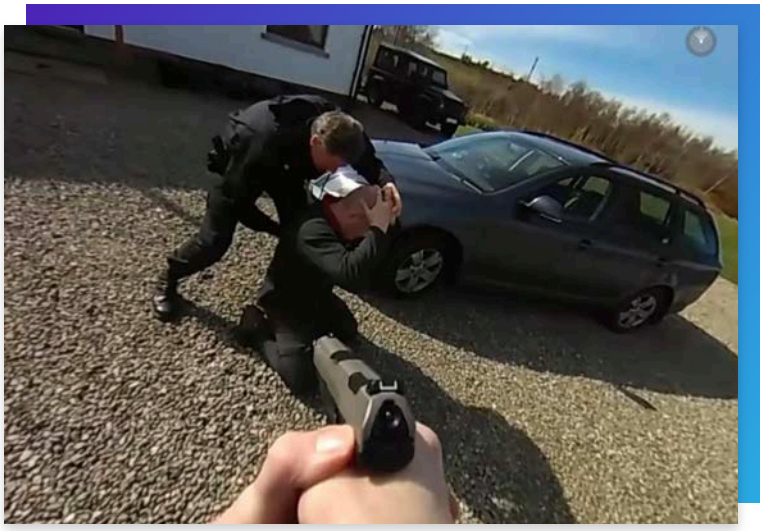


Photo courtesy of Sentireal
360 video of law enforcement training

3 Virtual Reality (VR)

Virtual Reality enables users to become fully immersed in a digital world created either by computer-generated graphics, photography, and/or video. VR allows users to interact with the virtual environment using hands (gestures), voice, and motion.

Some benefits from VR include:

- Interactive content in which the simulation can react to the user's input
- Fully immersive experiences, creating deep engagement with the learner
- Easy to vary or randomize by replacing individual pieces of content such as a prop, environment, or avatar

Some drawbacks of VR include:

- Technical and creative development resources required for production
- Limited functionality in lower end XR devices

Common training uses of Virtual Reality include:

- Learning and mastering equipment usage
- Practicing personal interaction skills with digital avatars
- Understanding safety and security protocols

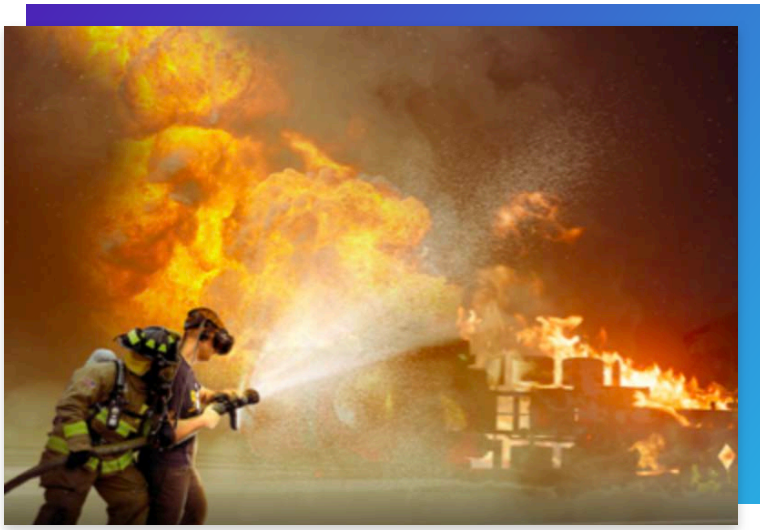


Photo courtesy of PIXO VR
First responder training

3 Augmented Reality (AR)

Augmented Reality allows users to view their real-world surroundings with a digital overlay. This digital content can appear on the surface of an object (providing relevant text or images about the object the user is viewing), or below the surface (acting like x-ray vision). It can also help users visualize a virtual object in a real space.

Some benefits from AR include

- Available on many modern mobile phones and devices
- Screen-based interactions for familiar UI/ UX
- Convenient method of displaying contextual data about real-world objects

Some drawbacks of AR include:

- Technical and creative development resources required for production
- Limited viewing area based on the device screen size

Common training uses of Augmented Reality include:

- Referencing details of a particular widget
- Providing real-time diagnostic information
- Making contextual resources available to reinforce previous learning

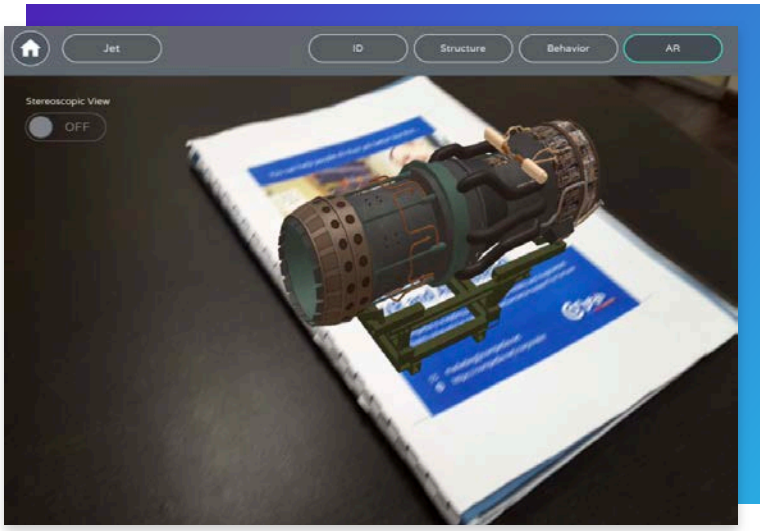


Photo courtesy of SkillReal
AR being used to enhance Classroom training

3

Mixed Reality (MR)

While traditional AR uses cameras and then overlays the image with computer-generated objects, Mixed Reality headsets overlay computer-generated objects onto a clear lens, thus mixing the physical and digital worlds in a potentially seamless manner. Mixed Reality also gives the user the ability to interact with virtual objects.

Most mixed reality headsets enable users to be untethered (completely hands free) and have full visual perception of their surroundings. This makes the technology a powerful tool for workflow improvement, on-the-job assistance, and just-in-time training.

Few Mixed Reality devices are currently available for enterprise deployment.

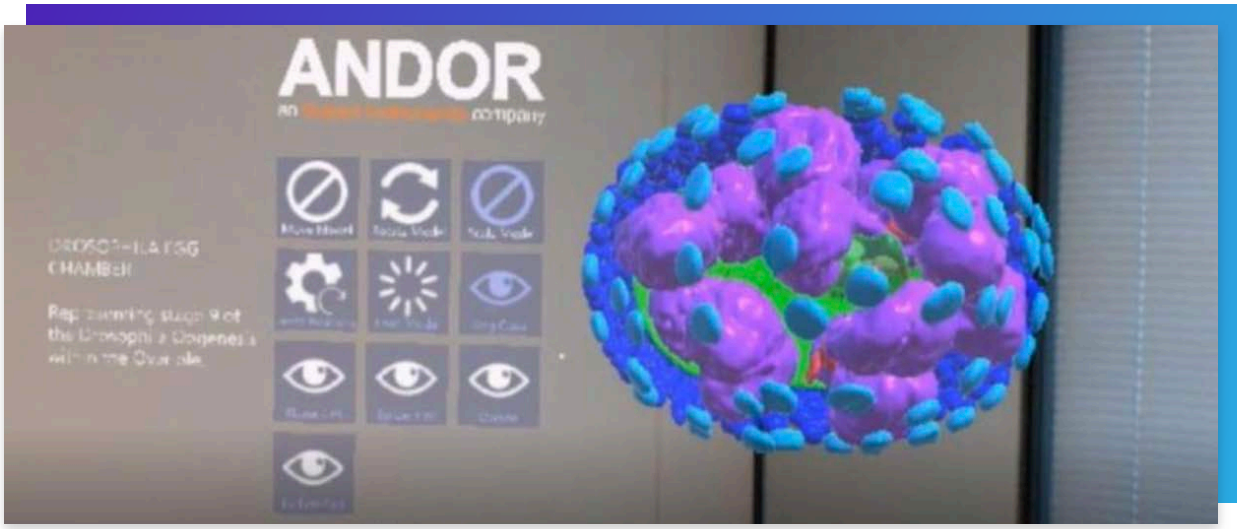


Photo courtesy of Sentireal
MR being used for medical training

4 Managing an XR Project

If you are using XR, or a particular XR technology, for the first time, we recommend using Agile methodologies for managing the project. While this document is not designed as an introduction to Agile methodologies, some key points include:

- Constantly review the technology options. This technology is moving at a fast pace, so options may change during the course of defining the initiative.

- Ensure the business team is integrated with the technology team.

- Prototype early to get user feedback.

- Allow learning design requirements to be negotiable. XR experiences are a merge of technology and learning design, so it requires constant collaboration between the two.

- Perform frequent technical and user testing; don't wait for the final product. This will ensure you address issues such as compatibility and usability early.

Defining Goals

Before beginning any project of this nature, it's imperative to set out clearly defined goals for the XR training program. While this is certainly part of the development of any training program, there are new questions that arise when bringing XR elements into the training discussion. Some questions you will likely need to answer before starting on an XR training project might include:

- **What is the lesson you want to teach?**
While this seems like an obvious starting point, XR training scenarios work best when they are short, self-directed scenarios. When determining the lesson to teach, make it as specific as possible, breaking the scenario into multiple tracks if needed. For example, a 'Widget Repair' scenario might be segmented into several individual repair tasks.

- **How will you measure success, both in the training and on the job?**
If you plan on having certain metrics gathered as part of the XR training, whether it be from active testing of the employee or by passively gathering data about the employee's performance, identify and articulate those prior to beginning development.

- **How does XR benefit training in a way that can't be achieved through traditional training methods?**
What specifically is XR adding to the training benefit? Just because XR is the new-and-shiny toy doesn't mean that it automatically makes training better. Where training in XR shines is in cases where the training was conceived in a manner that took advantage of the XR technologies to provide a learning experience that wasn't available in any classroom or video.

4

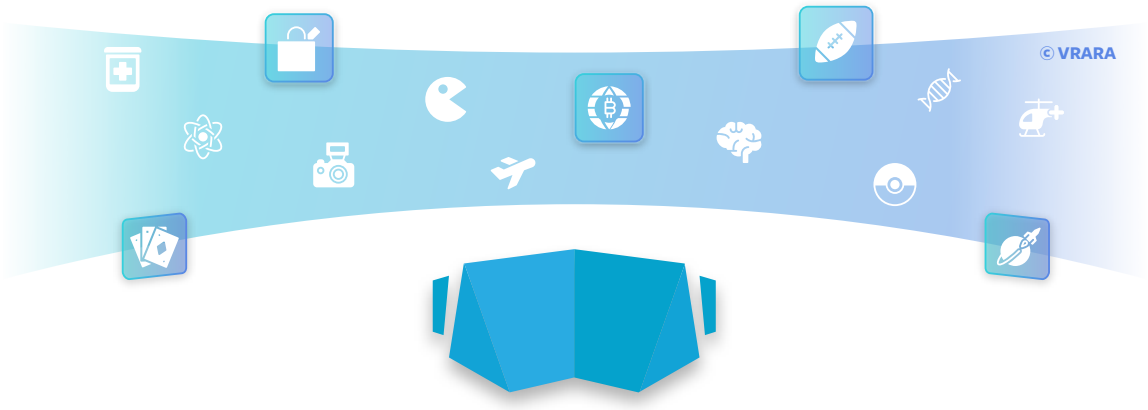
For example, is there a particular advantage to creating a realistic, immersive setting for the training? XR can provide that without requiring employees to travel. Or creating virtual avatars that elicit empathy? XR training can feature robust, intuitive avatars that react to the learner. Perhaps you have a situation that involves expensive, fragile equipment. XR would allow you to set up that equipment instantaneously, without any risk of permanent damage or misuse.

- **Where do you want employees to perform the training?**

Some XR training scenarios require a specific physical set up, for example an empty room with a Virtual Reality station. Remember that when working in Virtual Reality, employees will not be able to see the world around them, so having a safe space for them to move around in where they won't collide with furniture, walls, or other employees is crucial.

- **What technical support is available, if any?**

If you are reliant on hardware and software to run or enhance your training, what is your plan to support it?



5 Structure

With XR training, you have a lot of liberty in how courses are structured. Narrative elements can branch based on employee input or behavior, setups can vary, and learners can direct the flow of information at a pace comfortable to them.

When looking at how to structure a particular piece of XR content, here are some tips to keep in mind:

• Short, relatable lessons work well. Headsets can get heavy and users can experience eye strain after prolonged XR use. When appropriate, break lessons down into smaller, distinct packages. Employees often need an initial adjustment period to familiarize themselves with the equipment, controllers, and the virtual environment.

• Starting each lesson with a tutorial will help users quickly acclimate to their virtual environment and controls. You have no control over where the employee is looking, so make sure that your content is providing value no matter the user's focal point. (Also see hints on directing user focus below.)

• Because XR training tends not to be reliant on trainers or other personnel, consider how content can be used not only as initial training but also as ongoing follow-up, reinforcement, and assessment of your organization's policies, procedures, brand, and values.

• Virtual environments can bring learners together despite geographic distance. A learner in San Francisco can share the same virtual space with another learner from New York and a trainer based in London. Learners can work together to assemble equipment, evaluate safety standards, or review proper housekeeping protocols without needing to be physically in the same space.

6 Engagement

Building employee engagement through training has always been a challenge. You can use many of the features of XR technologies to engage your employees as active participants in the training. Active engagement can lead to significantly higher comprehension during training and improved retention of information once the training has completed.

- Don't feel limited by a single narrative thread. Employees can provide input through gaze, controllers, actions, or voice. This input can, in turn, affect the next segment of the training. Randomization can also be used to drive engagement, ensuring learners have a unique experience.

- Ask the employee to perform specific tasks from time to time. This forces activity and makes the employee immediately engaged and invested in the task at hand. The task can be simple, like "look around for the exit doors" or complex like "begin assembling the widget in front of you."

- If using an XR device with hand-held controllers or gesture input, incorporate these elements into the training. This not only makes a more comprehensive and accurate training simulation, but also stimulates engagement in the learner.

- Most XR headsets have a microphone built in, so incorporate speech into appropriate training segments. Again, this could be simple commands like "go to the parts room" or full-fledged conversations with digital avatars backed by artificial intelligence.

- If using an XR device with hand-held controllers like the Oculus Rift or HTC Vive, think of not only how to receive input from the user from the devices, but also how you can provide haptic feedback via the vibrations in the controllers.

- Use all of the environment. This not only increases employee engagement, but it also helps provide crucial context for the training matter at hand.

7 UI/ UX considerations

XR presents a series of interesting challenges for User Interaction (UI) and User Experience (UX). Most XR experiences, especially from a training perspective, rely on the user's environment and surroundings being rooted in familiar structures. Elements such as text overlays, buttons, and menus can break the illusion for users, as these elements do not traditionally exist in the real world. However, in traditional computer-based programs, UI/ UX elements such as these are essential.

Ideally, most UI/ UX elements would be incorporated into the virtual environment. For example, if you need to give an employee a specific instruction, showing that instruction as text in the virtual field of view can be distracting. What are other options for communicating this message to the employee? Voice over can often provide a strong method of presenting information and feedback directly to a user. Alternatively, think of how the messaging can be incorporated into the environment. If there is a virtual computer terminal available, could messaging be displayed via the computer terminal? Could the employee get a virtual text message or phone call?

When considering getting input from a user, make the input methods as natural as possible. Tracking the user's gaze with a reticle provides an easy-to-understand method of gathering user input. If using a controller, actions that mirror actual gestures and motions tend to be very successful.

In some cases, it may make sense to add additional controls to hand controllers, but as a general rule, XR training scenarios work best when the physical actions closely match those seen in the real environment.

7 Some other UI/ UX considerations

Current XR devices provide a lower pixel resolution and density than other display devices such as computer monitors or smartphones. One big drawback to this is that text tends not to look as crisp when displayed in XR. Take great care in creating text, and limit its use where you can.

Also, when displaying text, ensure that the text is anchored somewhere in the physical environment. If locked to the headset (meaning that the text always occupies the same space in the user's view), text can become even more difficult to read.

For interactive elements, find a way to clearly delineate which objects in your scenario allow interactions and which do not. Some common ways to do this would be to indicate interactivity with glow effects or arrows. If you are using controllers, another option would be change the shape and/ or shading of the user's hands to demonstrate that the object they are near allows interactions.

Be cognizant of where you are placing interactive objects within a scenario. When clustered closely together, selecting with precision can be difficult, especially with a gaze mechanic. Make outlines bold and clear; decorative or embellished borders can make the active area of an object unclear.

Make sure you think through scenarios of user-experience-gone-wrong. What happens if a user needs to hold a tool and accidentally drops it? Items that a user needs should never be out of reach, even if the user were to accidentally drop or toss the item. Make sure that necessary items are always accessible from a comfortable standing or seated position. Often times, scenarios will allow items to respawn in their original location if it is determined that they are no longer easily accessible by the user.

8 Motion and Locomotion

Moving a user around a space creates a unique challenge for Virtual Reality. (In Augmented and Mixed Realities, this is less of an issue because the user can see the world around them.) In Virtual Reality, the user is restricted by the physical space they are in.

In many training scenarios, it is important for the user to move from one area of the simulation to another. Moving the user can often cause feelings of motion sickness. Some ways to avoid or minimize the problem include:

- Blink the user to the new location. This method involves dipping the user's view to black for a fraction of a second and then re-locating the user to the desired location during the short blackout. This can be momentarily disorienting as the user appears in a new area, but it can lessen the effect of motion sickness for some users.

- While moving the user, move at a constant speed; do not accelerate or decelerate.

- Allow the user's gaze to remain free; do not force a particular direction of looking upon the user

- Reduce the periphery of the visible area. By reducing the size of the viewable area (and leaving the periphery black or gray), the effects of motion sickness are often greatly reduced. Some users have found a further reduction by filling in the periphery with grid lines instead of pure black/grey

9 Directing User Attention and Focus

The increased freedom of allowing a user to look in 360 degrees is one of the great advantages to XR technologies. While this creates a great sense of immersion, it also creates a problem of not being able to control the user's gaze. At times during your training scenario, having the user's full and undivided attention is important.

If you need to direct a user's attention to a particular area of a scenario, here are some helpful tips for encouraging a user to alter their gaze to your desired destination.

- Gray out or desaturate unimportant areas. The user will recognize the brightly colored areas as the correct point of focus.

- Use arrows or glow effects to indicate the direction in which you want the user to look.

- Small, fast, shiny glints or lens flares can attract the user's attention without being as obtrusive as arrows.

- Audio cues can draw a user's attention

Remember, you can always pause the scenario and wait for the user to regain focus on your desired area. Because xR technologies are new, many users spend a lot of time exploring their environments. This is to be expected, so please be patient with new users as they learn to use the new equipment.

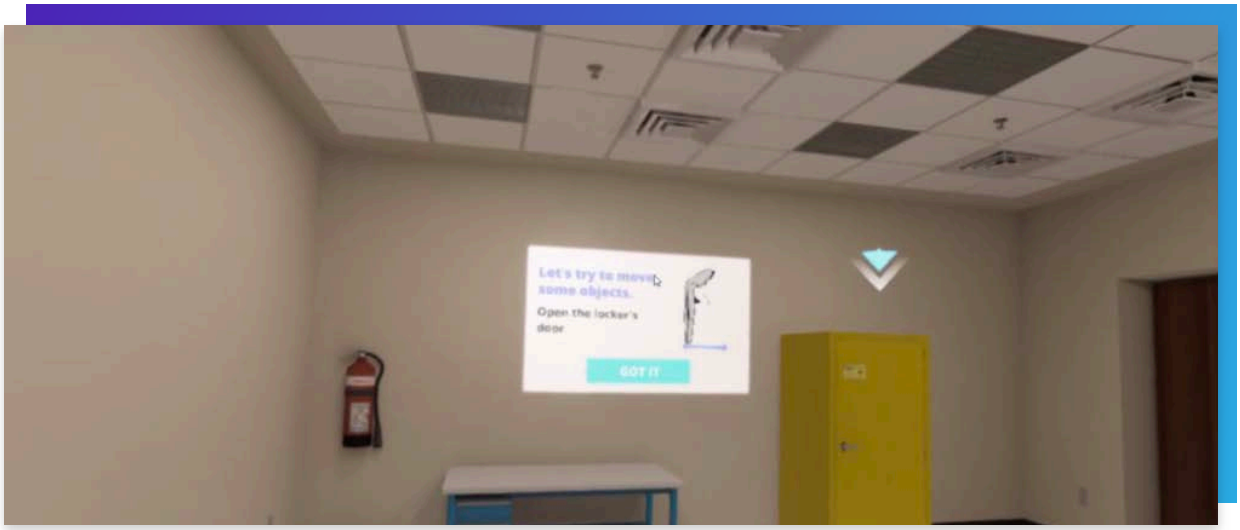


Photo courtesy of SkillReal, Use arrows to direct users in VR Scene from Virtual Reality Electrical Safety Training

10 Raising the Stakes / Creating Impactful Scenarios

Training can be at its most effective when it creates a sense of importance for the learner. In traditional training scenarios, communicating what's at stake can often be difficult. An instruction saying "then the customer might storm out" or "that might cause a fire" certainly describes some of the reasons behind training, but it often lacks the impact to truly resonate with the learner.

With XR technologies, you have the opportunity to truly raise the stakes with your learners. Instead of describing outcomes (good or bad), you can show them directly to the learner in fully realized, immersive scenes. Showing a fire that is caused by a misplacement of certain products is much more effective at building awareness and retention than merely describing it.

If using characters (whether computer generated or filmed actors), you can create poignant empathetic relationships with the learners. You can leverage this relationship to underscore the importance that a user's actions can have on other people, be they co-workers, customers, clients, or guests.

XR provides a safe way to depict dangerous situations without bringing any harm to the user. Furthermore, because it is all contained in the headset, there is little, if anything, to set up to prepare the scenario.

By showing risks and consequences of certain behaviors in an engaging, immersive way, learners are significantly more apt to retain this knowledge and adapt performance on the job.

11 Comfort and Patience

Beyond mobility concerns, XR technologies have a certain level of user comfort that must be maintained. First and foremost, XR technologies rely on tricking the eyes and the brain into seeing something that is not truly there. In order for this illusion to persist, the performance of the training application must maintain a high frame rate (please see your target device development guide for specific instructions, although most devices recommend maintaining 90 frames per second).

When creating computer-generated models and environments, always keep performance in mind. When framerates start to drop in XR, the user's experience quickly sours. From a development and content creation standpoint, this creates a delicate balance of wanting to keep the environment rich, detailed, and immersive but also wanting to keep objects to a minimum so as to guarantee performance. While there is no single solution to this predicament, here are some helpful tips:

- Multiple objects with high polygon counts can create performance issues. Remember that the resolution inside an XR headset is currently less that what you see on standard display devices (monitors, TVs, and phones), so choose a level of detail with that in mind.

- Higher resolution textures can help make a lower polygon count mesh look fantastic at a fraction of the performance cost

- Optimize your textures into atlases

- Test on device frequently to assure performance

Lastly, please remember that this is not only a new technology for you as you develop the training scenarios, but it is also new to your users. Please allow patience as the users get comfortable with the new gear. Allow time for them to explore the environment at their own pace before beginning the training. Also, you may want to include some optional additional training on how to use the equipment and how best to interact with the scenarios that you have developed.

12 Conclusions and Recommendations for First Steps

XR technologies offer many new opportunities for enhancing the impact of training and for offering new value to your learners and organizations. Technology is no longer a major barrier in implementing good XR solutions. The major challenges today involve the continuing expansion of knowledge, skill sets, and practices required to implement good training and development solutions.

XR provides many advantages to training. We invite you to seek the right opportunities to introduce these tools into your organizational learning portfolio. The VRARA and its Training Committee are here to help you out in your first steps.

Here are a few final suggestions to help you get started on this fascinating and immersive path:

1. Choose the Right Opportunity - Seek out opportunities for notable ROI and a clear business impact.

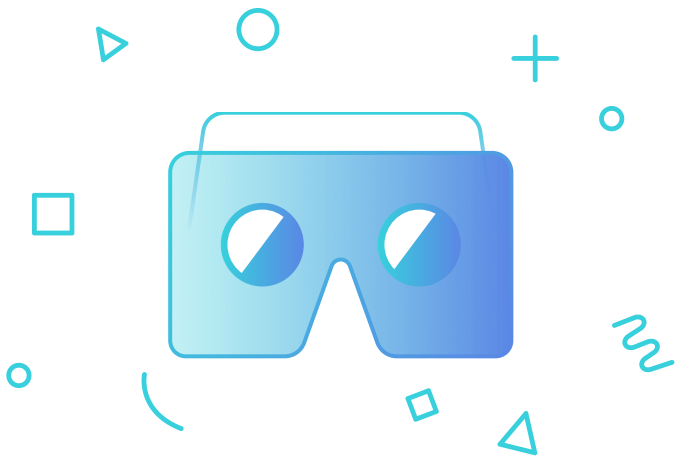
2. Leverage the XR Advantage - Strive to make the most of what these new mediums allow.
Make it as close as possible to real performance & practice.

3. Know Your Audience - Adapt the experience accordingly. What are they ready for? What are their critical needs? What will they be comfortable with?

4. Consider Blend & Flow - Plan and prepare XR as part of the full program. Add theory & foundations with classroom, e-learning, video. Make XR experiences available in various parts the flow.

5. Start Focused & Plan Big - Choose a pilot or small project that will be easy to implement and create a great first impression. Consider how the solution can be scaled up to reach larger audiences, address multiple business needs, and be used to create a foundation for widespread XR implementation in the future.

6. Support Ongoing Implementation - Test frequently and get feedback on projects. Listen to rising needs and ideas and adjust on the go. Resolve technical problems quickly. Measure and demonstrate results.



13 Glossary

AR
Augmented Reality combines a traditional camera-and-screen device (such as a smartphone) with computer imaging to make computer-generated images appear as if they are part of the world seen by the camera.

3DoF
3 Degrees of Freedom refers to the rotational movement tracked by hand controllers in XR devices.
The 3 degrees are: Pitch, Yaw, Roll

6DoF
6 Degrees of Freedom refers to the rotational and directional movement tracked by hand controllers in XR devices.
The 6 degrees are: Up & Down (Directional), Left & Right (Directional), Forward & Back (Directional), Pitch (Rotational), Yaw (Rotational), Roll (Rotational)

Game Engine
Game engines are common development tools for XR. While not necessary, game engines provide a variety of well supported built-in tools for developing new technologies. The most common game engines for XR development are Unity and Unreal.

Gaze Control or Gaze Gestures
Gaze control is when the direction of your head is used to interact inside the XR experience. Highly sophisticated headsets can even determine your gaze by picking up on your eye movement. In its simplest form, gaze control is often used to select an item from a menu.

Gesture Control
Similar to gaze control, gesture control is where sensors identify real-world hand movements as a cue to interacting inside an XR experience. A popular device that uses gestures is the Microsoft Hololens - where you will see users pinching the air as a method to select something inside the MR experience.

Haptics
Haptic is the name given to technology that allows sensory feedback somewhere on your body. A common example of haptics are the vibrations that gamers feel in their controllers.

HMD
Head Mounted Displays are devices worn on your head with digital displays placed in front of your eyes. There are many levels of HMDs from smartphone led 'cardboard' to full tetherless HMD's with 6DoF.

13 Glossary

MR
Mixed reality projects computer-generated images onto a clear visor worn by the user. It gives the impression that those generated images are part of the surrounding world.

Presence
Presence is a term used in XR when you feel present in your extended experience. This is often achieved when your eyes, ears, and body have a congruent experience.

360 Stereoscopic Video
A type of 360 video that uses separate cameras for each eye.

360 Video
This type of video is a method of capturing video in all directions and allowing users to control the direction of viewing during playback.

VR
Virtual Reality is a computer-generated world experienced by users with a headset. It is called virtual reality because the purpose of the technology is to trick the mind visually into believing an alternative to the 'real' reality. This is not to be confused with 360 Video.

Windows MR
Windows Mixed Reality is the term given to Virtual Reality that is delivered via Windows 10. This should not be confused with MR delivered via Microsoft's Hololens product.

XR
Extended Reality is the umbrella term used to describe experiences that provide an extension of the users/viewers current reality. This document uses term XR when discussion a collective of immersive technologies